LIBRARY

THE TEACHING OF SCIENCE IN THE ELEM

WITHDRAWN

3 4211 000086579

RIVERSIDE TEXTBOOKS
IN EDUCATION

EDITED BY ELLWOOD P. CUBBERLEY

PROFESSOR OF EDUCATION
LELAND STANFORD JUNIOR UNIVERSITY

DIVISION OF SECONDARY EDUCATION
UNDER THE EDITORIAL DIRECTION
OF ALEXANDER INGLIS

ASSISTANT PROFESSOR OF EDUCATION
HARVARD UNIVERSITY

Digitized by the Internet Archive
in 2025

https://archive.org/details/teachingofscienc0000gilb

THE TEACHING OF SCIENCE IN THE ELEMENTARY SCHOOL

BY

GILBERT H. TRAFTON
INSTRUCTOR IN SCIENCE AT THE STATE NORMAL SCHOOL, MANKATO, MINN.

KLINCK MEMORIAL LIBRARY
Concordia Teachers College
River Forest, Illinois 60305

HOUGHTON MIFFLIN COMPANY
BOSTON NEW YORK CHICAGO
The Riverside Press Cambridge

COPYRIGHT, 1918, BY GILBERT H. TRAFTON

ALL RIGHTS RESERVED

TEACHERS COLLEGE LIBRARY COLUMBIA UNIVERSITY

The Riverside Press
CAMBRIDGE · MASSACHUSETTS
U . S . A

1480

EDITOR'S INTRODUCTION

That we as a nation shall need to pay greater attention to instruction in science after the Great War than we did before it, now seems certain. The call for men trained along scientific lines for work in the fields and in the shops will inevitably be more insistent than any we have previously known. Research, too, along scientific lines seems certain to be cared for in a new way and to be greatly extended in scope. Our leaders now see clearly that if this nation is to hold its proper place in the life of the world it must become, to a much greater extent than ever before, a scientific nation.

To become a scientific nation, however, just as to become an artistic, or a literary, or a moral, or a practical, or an economical nation, demands that the masses be trained in the elements of these things, for from the many the great leaders must be drawn. This involves not only good instruction in the universities and secondary schools for those possessing special aptitudes, but general instruction in the elementary schools that the many may have any latent possibilities awakened, and may also be brought into sympathetic appreciation with the new turn it is desired that our national life should take.

Science instruction, or the awakening during childhood of an intelligent interest in the world of nature which lies all about us, has an important educational as well as a practical value. To become trained to observe plant and animal life and the phenomena of the universe accurately and appreciatively is a great educational asset. How to give such instruction to children has long been one of the per-

plexing problems faced by those charged with the responsibilities of school administration. One of the chief difficulties met with, especially in rural and village schools, has been that the teachers themselves, untrained along scientific lines, have not known what to do, how to do it, or where to get materials. The abundance of possibilities for instruction in scientific observation, the ease with which simple scientific experiments may be performed in the classroom, and the constant application of scientific truths to the daily life of all have been lost sight of in the feeling that only the most important things should be taught and that expensive apparatus and equipment are necessary to teach them.

The author of the present volume in this series of textbooks has tried, out of his long experience as a teacher of elementary science to children and to prospective teachers of children, to construct a simple and helpful volume for the teacher who is called upon to teach elementary science lessons, and yet has neither scientific training nor apparatus for the work. He has selected and graded the easiest and most interesting things to do in each of the main fields of science, has prefaced this by a brief discussion as to aims and methods, and has then supplemented it all by a detailed outline of what may be done, by years and by grades, by a teacher working alone and thrown upon her own resources. The volume should prove helpful to all teachers who are anxious to impart such instruction to their children, yet who need a suggestive guide which will show them the many possibilities lying within easy reach. That the work suggested and outlined has been carefully tested by the author, with children under actual school conditions, adds much to the value of the outlines and suggestions here presented.

ELLWOOD P. CUBBERLEY

PREFACE

The part that science plays in modern life is so vital that science teaching must inevitably have an important place in the school curriculum. There has been some confusion regarding the term to be used to cover the work in science in the elementary school. "Nature-study" has been the word in most common usage. But there is considerable misunderstanding as to what is included under this term. In recent years it has been used in an ever-broadening sense till now the word is used by many educators to include all phases of science adapted to the elementary school. But among people in general the common notion still prevails that nature-study includes only the study of wild plants and animals. So that, considering all sides of the matter, it has seemed better to the author to adopt the word "science" instead of nature-study, as tending to involve less misunderstanding and as helping to establish an appropriate and standard term.

The modifying words, "elementary," or "introduction to," seem superfluous. As we have history and English in the grades, so we have science; and it is just as unnecessary to speak of elementary science, or introduction to science, as it is to speak of elementary history or introduction to English. It is presupposed that any subject taught in the elementary school is to be adapted to the needs and capabilities of the children.

It should be clearly understood that nature-study and science are not different subjects, but that they are two terms variously used to cover the same subject-matter.

Three possibilities have presented themselves to the au-

thor: first, to devote the entire space to subject-matter alone; second, to devote the entire space to the teaching side alone; and third, to cover both fields. The last possibility seems out of the question because both phases cannot be adequately treated within the limits of a single textbook usually set by publishers. The first possibility was rejected because so many good books have appeared covering nature topics. The author has accepted the second possibility as offering the greatest need at the present time and has devoted the entire book to methods of teaching science.

The author has attempted to give a general view of the principles involved in teaching science, and has suggested the organization of a number of topics, leaving the details to be worked out by the teacher, either from other books or from her own experiences.

Special thanks are due Miss Helen M. Reynolds, Principal of the Primary Department of the Mankato Training School, for help in preparing the outline for the primary grades.

GILBERT H. TRAFTON

CONTENTS

PART I

THE PEDAGOGY OF SCIENCE INSTRUCTION

I. The Content and Place of Science 3
II. Aims of Science Teaching 10
III. Materials and Correlation 17
IV. Motivation of Science Teaching 26
V. Methods of Teaching Science 36

PART II

BIOLOGICAL SCIENCE

VI. Teaching Children about Birds 49
VII. Teaching Children about Insects 69
VIII. Pets and Domesticated Animals (for Primary Grades) 82
IX. Lessons on Trees 88
X. Lessons with Flowers 99
XI. Seed-Dispersal and Flowerless Plants 105

PART III

AGRICULTURAL SCIENCE

XII. Gardening 113
XIII. Lessons with Weeds 135

PART IV

HYGIENE

XIV. Principles underlying the Teaching of Hygiene 143
XV. Teaching Hygiene through Experiments . . 159

PART V

PHYSICAL SCIENCE

XVI. Physics and Chemistry 169
XVII. Weather and Sky Studies 185

PART VI

OUTLINE OF SCIENCE INSTRUCTION

XVIII. Basis for Organization of Outline of Science . 193
XIX. Detailed Outline of Science by Topics and Problems, arranged according to Grades and Seasons 205

BIBLIOGRAPHY 283

INDEX 289

THE TEACHING OF SCIENCE IN THE ELEMENTARY SCHOOL

PART I

THE PEDAGOGY OF SCIENCE INSTRUCTION

THE TEACHING OF SCIENCE IN THE ELEMENTARY SCHOOL

CHAPTER I

THE CONTENT AND PLACE OF SCIENCE

Phases of science. There are four large phases of science in the elementary school: the biological, the agricultural, the physical, and the hygienic. Biological science is a term which the author uses in a somewhat limited sense to include the study of wild plants and animals. Agricultural science includes some phases of elementary agriculture, centering chiefly around gardening and including some closely allied topics, such as weeds and soils. Physical science includes those phases of physics, chemistry, and astronomy which are adapted to the elementary schools. The hygiene phase of science includes the teaching of the laws of personal hygiene and public sanitation.

Emphasis on phases. The emphasis to be placed on these phases depends upon the age of the child and upon his environment. The biological phase receives special attention in the lower grades, diminishing in importance in the upper grades. The agricultural phase receives emphasis in the intermediate and grammar grades. The physical phase has its beginnings in the intermediate grades and receives special attention in the grammar grades. Hygiene receives some attention through all the grades, beginning with the primary and increasing in importance in the later grades. By this it is not meant to imply that the health of the child in the primary grades demands less attention than in the later

grades; but it means that more time can be given to the formal teaching of hygiene in the upper grades, because the age of the children makes it possible to give more consideration to the laws of hygiene and to the reasons for their observance. In the lower grades little time need be given to formal lessons in hygiene, but emphasis should be placed on the formation of proper health habits.

The distribution of these various phases of science according to grades is shown graphically in the accompanying diagram.

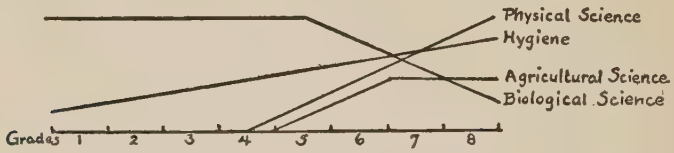

FIG. 1. DISTRIBUTION OF PHASES OF SCIENCE THROUGHOUT GRADES

Child's need of science. It is a fundamental principle of teaching that the child should be educated in terms of his environment. His daily life is to be the guide for the school. The underlying reason why the child needs science is because science plays such a vital part in his every-day life. This is a scientific age, when science dominates our life; and it will continue to dominate it with ever-increasing power in the future. In order that the child may play his part efficiently in this scientific environment, it is necessary that he should be educated regarding it in the schools.

Wild plants and animals in the child's environment. The child is closely surrounded on every side with a great variety of plant and animal forms, and these will continue to play an important part in all his life. They constitute one of the most evident and essential parts of his immediate environment. Some of these forms, such as birds and forests, are of great value to him. He should know this so as to protect them.

Other forms, such as weeds and some insects, are injurious to him. He should know this so as to protect himself from them. Some of these plants and animals, such as birds, trees, and flowers, are the chief factors that make outdoor life attractive. He should know these so that he may better appreciate this great source of enjoyment.

Why we fail to appreciate the importance of science. The true value of nature knowledge in the child's life is not fully appreciated because most people have had little of this training, and so do not understand its value. It is only when one has once acquired it, and then imagines that he is to be deprived of it, that he appreciates its real value. If we wish to realize the true value of our railroads, let us imagine that we are to be deprived of their services for a short time; and yet people existed for thousands of years and made much progress without any railroads at all. So people have gone through our elementary schools without a study of nature, and hence do not appreciate how much it would have meant to them. Those persons who have acquired this knowledge are the ones best fitted to judge of its value; and the general consensus of testimony from these persons is that this experience forms a vital part of their life, from which they could ill afford to part. This spirit has been well expressed by a writer in the *Nature-Study Review* as follows: —

> The love of nature aroused in that schoolroom under the guidance of a teacher who was herself a lover of the fields and woods, has given more pleasure than all else in life combined.

Agriculture and the child's life. The whole human race is indebted in the most intimate way possible to agriculture. To the country child it is his father's vocation and he is living constantly in the midst of agricultural activities and reminders. They form a vital part of his life. They are also vital to the town child, only removed one step farther, so that

the connection is not so plain. But even here are seen the elementary phases of agriculture in gardening, and the child may himself engage in its activities and derive profit and pleasure therefrom.

Applications of modern science. For the great majority of those things that contribute to the comforts and necessities of the child's daily life, he is indebted to modern means of travel. The locomotive, the electric trolley, and the automobile are in constant use in carrying the child from place to place. But of even greater importance is the part they play in bringing into his home those things that he uses daily. The steamboat and locomotive bring the child food and clothing from all parts of the world: fruits from Florida and California, rice from China, and silks from France. The locomotive takes a letter from New York to San Francisco and brings back an answer, all within a fortnight.

The water wheel, the motor, and the steam engine turn the wheels in the factories where the child's clothing is woven and much of his food is prepared. They run the machines that saw the lumber out of which his home is constructed; they turn the lathes and run the saws that make the tables and chairs used in his home. It is difficult to look anywhere that one does not find evidences of the part that these machines play in contributing to the child's every-day conveniences.

The telegraph and the telephone make it possible through the newspapers to keep informed of what is happening in all parts of the world, only a short time after these events occur. The telephone has come to be a daily necessity so closely interwoven with our every-day activities as to be considered almost as much an essential in a modern home as is a watch or clock.

Many of the child's chief pleasures are made possible through the applications of science. Probably no other one

thing furnishes enjoyment to so many people, children and adults alike, as the moving pictures. It has been estimated that fourteen million people visit the moving pictures every day in the United States. These pictures are made possible through improvements in photography and devices for projecting pictures on the screen. The phonograph and the great variety of musical instruments, such as the piano and the violin, are applications of the physics of sound.

These examples that have been given are applications of modern science in the child's every-day life, and they constitute the chief reasons for the difference between life to-day and life a hundred years ago. These well-known illustrations have been cited to emphasize the fact that science plays a dominant part in the child's life. Hence, as a natural result, the study of science should have an important place in the school curriculum.

Hygiene and life. And finally, underlying everything else and more important than all else combined, is the conservation of the child's health. Teaching hygiene should form a vital part of the science work. The condition of the body underlies all that one does in life. The strong, healthy body gives the possibility of a long, useful, happy life. The weak body handicaps one in all walks in life in direct proportion to the extent of this weakness. Good health is the most precious thing that the individual can possess, and the conservation of this health should be the first consideration of the school.

These statements are self-evident, and it would seem almost needless to restate them, were it not for the lamentable fact that the laws of health are seriously violated by the individual, and the teaching of these laws is almost criminally neglected by the public schools. Statistics show that the death-rate in this country for people over forty years of age is increasing. This means that people are failing to follow

the laws of hygiene in their living. This is largely a matter of habits, and correct hygienic habits of living should be established during the school age of the child.

Quotations regarding the place of science. As evidence of the need of science teaching in our schools the two following quotations will suffice to indicate the opinion of educators who look at the school problem from a general viewpoint, and not merely from that of a specialist in science. Mr. Abraham Flexner, in his masterly and constructive paper entitled, *A Modern School*, writes regarding the science work: —

> The work in science should be the central and dominating feature of the school — a departure that is sound from the standpoint of psychology and necessary from the standpoint of our main purpose. Children would begin by getting acquainted with objects — animate and inanimate; they would learn to know trees, plants, animals, hills, streams, rocks, and to care for animals and plants. At the next stage, they would follow the life cycles of plants and animals, and study the processes to be observed in inanimate things. They would also begin experimentation — physical, chemical and biological. In the upper grades, science would gradually assume more systematic form. On the basis of abundant sense-acquired knowledge and with senses sharpened by constant use, children would be interested in problems and in the theoretic basis on which their solution depends. They will make and understand a fireless cooker, a camera, a wireless telegraph; and they will ultimately deal with phenomena and their relation in the most rigorous scientific form.

The Cleveland Survey volume on *What the Schools Teach and Might Teach* says: —

> No elaborate argument should be required to convince the authorities in charge of the school system of a modern city like Cleveland that in this ultra-scientific age the children who do not go beyond the elementary school — and they constitute a majority — need to possess a working knowledge of the rudiments of science if they are to make their lives effective. Considered from the stand-

point of actual human needs, the present almost complete neglect of elementary science is indefensible.

Science has long since passed beyond the stage of a fad, and is now a fundamental subject for the schools in the same sense that any subject is considered fundamental; that is, if the child has not had instruction in that subject, he has missed a vital part of his life, as a result of which he will be handicapped in life; he cannot himself derive so much pleasure from it, he cannot be so successful, nor can he be of so much service to others.

CHAPTER II

AIMS OF SCIENCE TEACHING

THE aims of any subject should be as broad as life itself, in so far as that subject touches the various phases of life. Science is so closely related to many vital aspects of human life that the aims of science teaching must be broad and comprehensive.

In order to teach any subject effectively the teacher must have clearly in mind the purposes to be served by that subject. This gives definiteness and directness to her teaching. In teaching science there is another special reason why a clear understanding of aims is essential for the best results. The discussion of the previous chapter suggests the tremendously broad field that science covers. It is self-evident that only a small portion of this field can be studied. How shall the teacher know which portions to cover? A clear understanding of the purposes of teaching science will serve as a guide in selecting from this large field. Those topics will be selected which best help to serve those purposes. Those portions which help least, or not at all, will be omitted.

Aims of education. In determining the aims of teaching science the fundamental consideration is the aim of education in general, as science is simply one subject in the school curriculum, and all subjects must coöperate to a common end. The purposes of education have been stated in many forms by different writers. It is fairly inclusive to say that education has four large aims: the vocational, the avocational, the social, and the hygienic. The vocational aim seeks to teach the individual how to earn a living; the avocational seeks to show him how to occupy his leisure hours, so that he

may derive greater pleasure in living; the social seeks to teach him his duties to his fellows; and the hygienic seeks to teach him how to conserve health. The vocational aim has no place in the elementary school, because the immaturity of the children does not permit a vocation to be taught. This leaves, therefore, a threefold aim for the elementary school — the avocational, the social, and the hygienic.

Science, as one of the subjects in the school curriculum, can very clearly contribute its share toward fulfilling each of these aims. So that we may take these same aims as our guide in teaching science. It is convenient to consider also the economic aim, which is not so much an additional aim as it is a particular aspect of the other aims, which it seems best for our purposes to treat separately under this head.

From still another more general standpoint, education has two great functions to perform: to promote the welfare of the individual and that of society. Both of these aspects are included in these aims. The æsthetic or avocational aim deals largely with individual welfare, the social aim with social welfare, and the hygienic and economic aims with both individual and social well-being.

Æsthetic or avocational aim. One important aim of science teaching is to furnish greater pleasure in living. Enjoyment is an element necessary for the most successful living. Every one demands and seeks some form of enjoyment, and rightly so. Some of the pleasures thus obtained are positively harmful, some are worthless, and others are helpful. One purpose of teaching science is to furnish a helpful kind of enjoyment that shall make life more worth living. The study of nature furnishes many opportunities to derive such pleasure. Through all his life one is surrounded with a wonderful variety of beautiful plant and animal forms. People are realizing to-day as never before the advantages of living outdoors in contact with nature. The enjoyment of life is

greatly increased, oftentimes, perhaps unconsciously, if one knows the trees that help so much to make the landscapes beautiful, and can name the flowers that adorn the roadsides and gardens, and sees and hears the birds that gladden the spring-time by their beautiful colors and musical songs.

The raising of flowers, vegetables, and fruits in the home garden is a source of much pleasure, as well as having economic and hygienic bearings.

Young children derive great pleasure in keeping pets, and the care of these pets has the further advantage that it helps to develop in children a sense of responsibility.

The pleasures that nature furnishes are of almost universal application, in that nearly every one may derive some enjoyment therefrom, if attention is called in school to these possibilities and children are taught to know the common forms of life that everywhere surround them. No special training is needed to enjoy these pleasures, and they are free to all.

The relative stress to be laid upon the various aims must evidently depend upon the age of the child. The æsthetic aim should be the dominant one for young children, and should become relatively less important for the older children, but should, however, be kept in mind throughout all the grades.

Economic aim. Somewhat in contrast with the æsthetic aim stands the economic aim, dealing with practical affairs. In the great variety of wild life are found both beneficial and injurious forms, the former of which should be protected, and the latter destroyed or controlled. Among birds we find that the great majority are beneficial. Among insects are found some of man's worst enemies. In the vegetable garden, in the fruit garden, among the field crops, and in the household are troublesome and dangerous pests which must be controlled. Some are even dangerous to human

life. On the other hand, there are many insects that are of great value to man. Weeds are another great pest wherever crops are raised. Every citizen needs to know something of the economic aspects of these numerous forms of life, in order that he may guide his actions more efficiently.

Gardening has an economic aspect worthy of careful consideration. The constant upward trend in the cost of living presents a serious problem for the great majority of people. A garden, even though small, may be one factor in helping to reduce the cost of living, and at the same time it may furnish the most healthful kinds of foods.

There are many applications of physical science, such as the telephone, the steam engine, and the automobile, which play so vital a part in modern life that some knowledge of their significance is essential to an intelligent existence amid present-day surroundings.

The economic aim may be kept in mind to some extent in the intermediate grades, and may share with the social aim the dominant place in the grammar grades.

Social aim. During recent years, the social aim of education has been strongly emphasized, and properly so. Man above all other forms of creation is a social being. As modern improvements and increase in population bring people closer together, both potentially and actually, and make them more dependent on each other, the duties that one owes to his fellows become of increasing importance. Cooperation, not competition, is the watchword of our advance to-day in all phases of activity — political, religious, and industrial, as well as educational.

In the teaching of science there are opportunities to show children how they may best perform their social duties and coöperate with others to promote the best welfare of all. Some forms of wild life, such as birds and forests, are of great value to the entire country, and should be protected

and preserved. During the years past the true value of birds and forests has not been appreciated, and these natural resources have been squandered even to the point of extinction of some species, of which the passenger pigeon is a recent example. We may teach our boys and girls that preservation of birds and forests is one of the duties of citizenship, and that for this coöperation is necessary.

And most important of all is the protection of the health of the community. For this coöperation is absolutely essential. As people are more and more gathering in towns and cities the necessity of working together becomes increasingly important. When a man lived on a farm far removed from neighbors many of his health problems were entirely personal, and concerned himself and family alone. But with the grouping of people in towns in close proximity many health problems must be solved in common, such as keeping the water supply pure, controlling contagious diseases, and disposing of garbage and sewage.

Thousands of people are killed every year through the agency of the fly and the mosquito in carrying diseases, and yet practically all of these deaths are needless, because by proper coöperation the citizens of a town can control these pests. The work in science may well be a means through which such an interest will be aroused in both children and parents, that efforts will be made which will lead to the control of these insects.

The wide extension of modern applications of science has done much to draw people of distant States together and to produce a feeling of unity and a greater toleration for others' viewpoints. This has helped to make a people more homogeneous in ideals and to produce a feeling of oneness that underlies a true national spirit.

The social aim may find its beginnings in the intermediate grades as soon as the age of the children enables them to

appreciate some of its phases, and should be one of the dominant aims of the grammar grades.

Hygienic aim. The need of a healthy body as the basis of all activities of life is self-evident, as is also the need of teaching boys and girls how to keep their bodies healthy. But, unfortunately, the practical working-out of the teaching of physiology in the schools seems to have been unsuccessful. It is difficult to get children interested in health for health's sake, but we may connect hygiene with other science topics and activities in which the child is interested. In connection with gardening may be taken up the question of exercise, and the study of fruits and vegetables as foods. In connection with the methods of heating the home there naturally arises the question of ventilation. The study of the fly brings up the subject of bacteria in relation to disease. And with other topics of hygiene it is believed that better results will follow if they are arranged as an organic part of the science course. The work in hygiene has been so incorporated in the outline of science given in chapter XIX.

The hygienic aim should be kept in mind throughout all the grades, beginning with the youngest children and increasing in importance as the advancing age of the children enables them better to understand the need and laws of hygienic living.

Abandoned disciplinary theory. In the years past the disciplinary aim of education has been dominant, in accordance with which the chief aim of education was to discipline the various powers of the mind, such as the powers of observation, reasoning, and memory in the belief that after these had been trained in school the powers thus acquired could be turned to use in any walk of life. In connection with science it was common to emphasize the value of training the power of observation. The researches of modern psychology compel the abandonment of this theory of gen-

eral discipline and the substitution of the theory of specific discipline, in accordance with which training that is received in school becomes useful elsewhere only when applied to the same or similar conditions. It would be beyond the purpose of this book to enter into a discussion of the theory of formal discipline; it will suffice merely to state that the results of numerous experiments have led practically every educator and psychologist in the country to abandon the theory of formal discipline, which has dominated our schools for so many years, and from whose shackles, unfortunately, many of the school subjects have not yet freed themselves.

In accordance with the modern interpretation the child should be taught in science to observe and reason about those things in school which it is desirable for him to observe and reason about in actual life. The use of the power of observation is a method by which science is taught, but the training of this power should not be the aim. It is a means, and not an end.

Another serious objection to the disciplinary theory is the fact that it is non-selective in its functioning. An aim should serve as a guide-post to the teacher, pointing out the things to be taught. The disciplinary aim does not serve this function, for the study of any one form of life will serve the purpose of developing the power of observation as well as the study of any other related form.

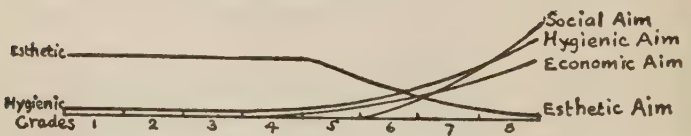

Fig. 2. Relative Emphasis on Aims of Science in Different Grades

The above diagram will suggest the relative stress to be placed on the various aims of science in the different grades. The distance of the curve above the base line represents the relative importance of that aim.

CHAPTER III

MATERIALS AND CORRELATION

Materials

One of the features that characterizes science and makes it worth while is the fact that it deals largely with the concrete things in the child's environment. In order that the child may derive the most benefit from his study, it is necessary that he should have actual concrete materials to use in his lessons. The procuring of materials for science lessons, then, is something for which the teacher should make definite plans. Frequently the assistance of the children may be sought in securing material, and this forms a valuable experience for the children.

Types of materials. The great mass of materials available may be classified into the following groups: (1) living things in their natural environment; (2) living things in the schoolroom; (3) preserved material; (4) pictures; (5) apparatus for demonstration and experiments.

(1) **Living material in natural environment.** The best kind of material for the study of plants and animals is the living object in its natural environment, because this is the way it is actually seen in the life of the child. This study of material outdoors may be carried on in two ways: by means of individual studies made by the children under the suggestions of the teacher, and by means of field trips in which the teacher accompanies a group of children. Both of these methods are desirable.

Individual observations by children. The first method of studying life in its natural environment, by encouraging and expecting the children to make studies by themselves, is

one of the most valuable lines of work that can be done. One of the applications which it is desirable that the child shall make throughout his life is the observation of the wild life around him; and the more closely we can approximate in school the application desired in life, the greater is the probability that this application will be made. In connection with each lesson the teacher may suggest some questions that the child may answer from outdoor studies of the topic of the lesson. For the older children these questions may be written on the board. At the next lesson an opportunity should be given for the children to make reports on what they have observed. As the children become more observant and self-reliant, fewer details will need to be given, and finally they may be thrown on their own responsibility regarding the points to be studied. One purpose of a lesson should be to arouse enough interest so that the children will want to make further studies of the topic under discussion. At first there will be many children who will not make these studies, but the number who do make them can be greatly increased by expecting the children to do this, the same as any home work, and by giving frequent opportunities for them to report on their observations.

This work will be greatly stimulated by keeping spring calendars of birds and flowers, in which a record is kept of the name of the bird or flower seen, the date when first seen, and the name of the child first reporting it. This record may be kept either on the blackboard or on a large piece of cardboard. Similar calendars may be kept of the leafing and flowering of trees in the spring and of the coloring and fall of the leaves in the autumn.

Field trips. The final desired end is that the child shall be observant of nature when by himself, and one of the chief values of the formal field trip with the teacher is that these trips may lead to this end. The teacher may arouse

an interest in the child and she may suggest what to study and how to observe. Thus the child will be led to individual observations.

This kind of work should be strongly emphasized wherever possible. The conditions in many of our schools are such that it is not practicable to take many field trips. But plans can often be made to take at least one trip a term. If a class is too large to be taken altogether, frequently arrangements can be made to take half of the class at a time and leave the other half in charge of the principal. This half may then be taken on a trip at some later time.

Careful preparation should be made by the teacher for this trip. She should go over the ground a day or two before the trip is to be taken and see just what material is available, and decide definitely on what the children are to study. She should make the purpose of the trip very clear to the children before starting, so that they may have a definite aim to guide them. There are so many distracting things that it is specially important that they should start out with this definite purpose. After certain outdoor studies have been made it may be wise in some cases to gather material, when feasible, and take it back to the schoolroom, where it may be studied more carefully with fewer things to distract the attention of the children.

(2) **Living material in the schoolroom.** In some ways the most practical kind of material is the living specimen kept in the schoolroom. Here the environment is missing, but life is still left. There is a great abundance of material available here. Various kinds of pets, including canaries, may be kept in the schoolroom for a short time. A great many insects, such as crickets, grasshoppers, caterpillars, and many others may be kept in glass jars covered with mosquito netting; mosquito wigglers may be kept in tum-

blers; fishes, tadpoles, snails, toad's eggs, and many kinds of water insects may be kept in glass jars filled with water. Nearly all kinds of plants may be kept in the schoolroom, such as flowers, leaves of trees, ferns, and mushrooms. Experiments may be performed with seeds and seedlings; and house plants, such as ferns, geraniums, and bulbs, can be kept permanently in the room.

(3) **Preserved specimens.** In the group of preserved specimens life and environment are both missing and only the form is left, but for some topics this kind of material serves the purpose well. Children can be set to work making collections, and thus while looking for materials they will find objects in their natural environment. Some of these materials may be collected and kept in the schoolroom without any preparation to preserve them; such as bird's nests, galls, cocoons, wasp's nests, tree fruits, specimens of woods, woody mushrooms, weed seeds, ears of corn, plants of wheat, and other cereal crops. Some materials, such as flowers, ferns, weeds, leaves of trees, shrubs, and vines, may be preserved by pressing them between the leaves of books or between the folds of newspapers, with weights placed upon them. Insects may be kept in glass mounts made of old negatives. The older boys, in connection with the work in manual training, may make a simple museum case in which these materials may be kept.

(4) **Pictures.** In the picture not only are the environment and life gone, but the thing itself as well, and we are dealing with only a representation of the real thing. But pictures have their place, and for some objects form very desirable material, as in the case of birds. These show the colors well, and many suggest something of the environment.

(5) **Apparatus for demonstration and experiments.** For much of the work in physical science, and for some work in hygiene and with plants, simple apparatus will be needed

for demonstrations and experiments. Suggestions are given in the chapters dealing with these topics.

The topic to be studied should be so chosen according to season that the illustrative material may be easily available. In many cases the children will help the teacher secure the material, but the teacher herself must take the final responsibility to see that the material is actually present when needed.

Amount of material. The amount of duplicate material needed for a lesson varies according to the topic. In some cases each child may be provided with a specimen for study, as with weeds, leaves, seeds, and many flowers. This makes an ideal situation, because each child has opportunity to make his own individual studies without depending on any one else. In many cases it is not feasible to procure material for each child. In some of these cases the teacher may plan to secure a specimen for each row of pupils. In still other cases only one specimen may be available for the whole room.

In the experimental work done in physical science one set of apparatus will be sufficient. The experiment may be performed by the teacher for the entire class, oftentimes with the assistance of some of the pupils.

How to use material. In using material one important principle should be kept in mind, that enough time should be taken to allow each child to study the material. Recent experiments have shown that the time factor is an important element in observation; that one of the chief ways to insure accurate observation is to allow plenty of time for the object to be studied. When only one specimen is available this thought should be especially kept in mind, because when the teacher simply holds up the material in the front of the room, only the few children near the teacher have a satisfactory opportunity to study the specimen, while those

in the rear of the room may get very little from the lesson. The material should be passed around by the teacher or some child, or else groups of children may come up in turn and study the specimen. This will take more time, but it is necessary if all the children are to derive the full value of the lesson. When only one specimen is available an excellent way to have it studied by all is to leave it on the table or window sill for several days, and suggest that the children study it at odd moments during the day.

If a specimen is provided for each row it may be studied by each child individually and handed back from seat to seat, or the children in each row may study it as a group.

One point to consider in the use of material by the children is the fact that when children handle material they are using another sense, that of touch as well as that of sight, and hence they learn more quickly than they would by sight alone because they are acquiring knowledge through two avenues.

Relation of science to other subjects

The nearer our schoolroom procedure can approach life conditions, the more effective will our teaching be, as the greater are the probabilities that the child will make use of that which he learns in school. Correlation is the natural and common procedure in ordinary life. The unit here is not the subject-matter involved, but the activity in which the person is engaged, and our ordinary activities involve a great variety of subjects. Hence, natural correlation is a desirable thing to be made an organic part of teaching. Convenience seems to demand that the various subjects should be taught separately, and hence there is all the more need that there should be found some interest which shall unite and correlate these various subjects.

Furthermore, psychology teaches that when a topic is

approached from several standpoints and taught in its relation to other things, it becomes more surely a part of the child's experiences than if taught disconnectedly.

Science and art. There are many opportunities for natural correlation in teaching science. This is specially true in connection with art, literature, and language. Many science topics permit of correlation with art. Much of the material used in the science lessons may be reproduced by the child by means of free-hand drawings with colored crayons for younger children, and outline drawings and paintings in water-colors for older children. For young children a large amount of hand work is necessary throughout all departments of school work, and the drawings may furnish some of this in connection with the nature-study lessons.

Science and literature. In literature will be found many references to nature, and he who would most truly appreciate literature needs to know something of the plants and animals to which reference is made. Our poets write often of birds, flowers, and trees; and whenever these forms are studied in the science lesson the study of some appropriate poem will add greatly to the child's appreciation of the object studied. It is also true from the standpoint of literature that the child's appreciation of the poem is increased through a study of the forms to which reference is made.

Science and geography. In home geography the correlation between nature-study and geography is so close that frequently the two are taught together for the first two or three grades under the name of nature-study. The relation between these subjects is also close in the later grades. Geography is constantly dealing with science topics, thus presenting a natural opportunity for correlation.

Other opportunities for correlation. There are also opportunities for the correlation of science with manual train-

ing in making bird-houses and fly-traps and in connection with the study of gardening. Problems for arithmetic may be found in connection with the study of birds, trees, and weeds. Opportunities for correlation with language are constantly presenting themselves. Reports by the children on what they have observed outdoors or what they have done in connection with outdoor activities, furnish excellent opportunities for teaching the correct use of English.

Methods of correlation. Correlation may be brought about in several ways. If it is desired to correlate science and art the following possibilities arise: first, during the art period a brief study from the science standpoint may be made of the material being drawn; second, during the science period drawings may be made of the materials being studied; and third, the same topic may be studied in both the science and art periods — in one from the science standpoint, in the other from the art standpoint. The method to be used will depend upon the conditions existing in the school. The last arrangement seems from some standpoints the ideal one, but under present conditions it is difficult to bring it about in the graded schools. If both subjects to be correlated are taught the methods suggested under one and two offer the best opportunity. If only one of the subjects is taught in the school the only possibility is to correlate with the other subject during the regular period of the first one. The writer suggests that the teacher may occasionally utilize a part of the science period for art work or for the study of literature appropriate to the topic.

The chart on page 25 may suggest some of the possibilities of correlation with a few leading science topics.

Correlation Chart of Science and Other School Subjects

Science topic	*Literature*	*Art*	*Geography*	*Arithmetic*	*Manual training*	*Language*	*Civics*
Birds	Read literature about the birds studied	Color outlines of birds Make artistic bird calendar	Migration Change in bird life according to seasons	Problems on the number of insects eaten by young birds	Make nesting houses, feederies, and fountains	Reports on outdoor observations	Bird club to protect birds
Trees	Read literature about the trees studied	Color autumn leaves Draw leaves, trees, winter twigs, fruits, sections of wood Freehand cuttings Charts	Forestry Seasonal changes in trees	Problems on height of trees and on board measure	Make collection of woods	Reports, both oral and written on outdoor observations	Conservation of forests
Flowers	Read literature about the flowers studied	Colored drawings of flowers and fruits Draw leaves	Flowers grouped according to season			Reports on outdoor observations	Protection of wild flowers
Gardening	In connection with garden activities, read poems about gardening	Cuttings and drawings of garden tools Drawings of seedlings, leaves, flowers, fruits Make plan of garden	Dependence of garden activities on seasons	Problems on measurement of garden and garden planting	Make window boxes, stakes, and labels for garden	Reports on garden activities as topic for composition work	Use of vacant lots Summer gardens under charge of city
Insects	Read poems about insects studied	Draw insects, cocoons, galls, wasps, nests		Problems on the amount of harm done	Make breeding cages	Topics for written work	Control of fly and mosquito by town authorities
Weeds		Draw plants and fruits		Problems on the number of seeds borne by a single plant	Make cases for holding weed seeds	Reports, both oral and written, on outdoor observations	Weeds in vacant lots Weed laws

CHAPTER IV

MOTIVATION OF SCIENCE TEACHING

One of the first and most fundamental things to which the teacher of science should give attention is proper motivation of the subject on the part of the child. Motivation involves three steps: first, a consideration of the children's experiences so as to make the proper connections; second, a problem to arouse the children's interest and to guide them in their work; and third, the use of what they have learned as the final outcome of what precedes. There has been in the past, and unfortunately still is, too much purposeless teaching of science and of other subjects as well; but it seems as though the defect were especially inexcusable in science, because the subject touches the child's life at so many vital points. The efficiency which modern life is demanding of the schools must cause us to substitute for this aimless, unguided study of nature topics a vital, purposeful study of those things that are worth while in the child's life.

The child and the curriculum. The first essential in proper motivation, is that the thing being done should be worth while from the child's standpoint. This brings us at once to the fundamental principle that the child is the determining factor in the school. Life must be viewed through the child's eyes, and the curriculum planned accordingly. Not only the method of teaching, but the content of the course must find its basis in the child's life. In the centuries past both the method and content found their basis in the life of the adult and not in that of the child. As a result of the psychological studies of the past century the principle

that the method of teaching should find its basis in the child's life has been universally accepted. The consequent practice of this principle has become fairly well established in our schools.

The studies of recent years have established the principle that the content of the school curriculum should also find its basis in the child's life. We are now in the midst of actually putting this principle into practice in our school procedure.

Fallacies of storage system of education. The old conception of basing the content of the course on the adult needs, — on what the child might need when he becomes an adult, — is based on a number of misconceptions of the value and fullness of child life, and on a misunderstanding of the laws of psychology. The old conception that the school should teach the child what he will need when he grows up has been aptly termed the storage system of education. The idea back of this is that the child's mind may be stored with facts that will prove useful in later life, and that they will be retained there and can be used whenever the adult finds need for them. This is based on two fallacies: First it assumes that knowledge which the child learns can be retained in mind a long time, even when not used, and then applied in later life. This assumption is false, because experiments have shown that knowledge is soon lost unless it is used. The second fallacy on which the storage system of education rests is the idea that child life in itself is barren and incomplete, and that it is only in adult life that experiences become really worth while.

Richness of child's life. Even a very hasty glance at child life shows that it is rich and full in those experiences that go to make up life, and that it is full of opportunities to make present use of knowledge. The bodily needs that relate to health are the same as those for the adult. The

same underlying principles of hygiene regarding food, air, and cleanliness apply to both alike. These laws of hygiene require constant daily application.

In enjoyment the child's life is a full one. Play naturally makes up a large and vital element in his life. He enjoys many of the same things as does the adult, of which the "movies" are a constant reminder. The child's enjoyment of physical bodily activities exceeds that of the adult.

The child's temptations and sorrows are just as real and varied to the child as they will be later in his adult life. True, his sorrows are transient, but nevertheless real. Perhaps in some ways the child is exposed to a greater variety of temptations than the adult, because the adult has most of his habits of life well established, and things which in earlier years were a constant temptation while habits were being formed, have now ceased to be temptations because established habits of right conduct have eliminated them.

Children's experiences abound in social life and its corresponding duties. The child's play life is largely a social life. To even a larger extent than the adult, children are together in their various activities. And in these gatherings there arise the same problems that arise in adult gatherings: leadership, duties to each other, the establishment of a basis on which intercourse is possible, the punishment of those who offend these requirements, and so on through a long list of social activities.

And so from morning till night the child's day is full of its activities and needs, quite as varied as those of the adult, and offering equal opportunities for the application of useful knowledge. The school should seek to give the child those things that these present activities demand.

Relation of present and future needs. In basing the content of the school subjects on the child's possible future needs as an adult, we find the serious difficulty that no one

1480

knows what a person will be doing and where he will be in the future, and, as a result, no specific individual education is possible, but only a vague general education. And even when one can see some things that the adult will need, such as the ability to read, still we must find the basis for teaching reading in the use that the child makes of it in his present life. And if one can foresee what the child will need later in life, but does not need and cannot use in his present, it will be useless to teach these things to the child, because they will soon be forgotten unless the child finds some immediate use for them. And, furthermore, many of the children will never live to reach adulthood, so that if we are thinking only or chiefly of the future, in these cases the energy and time spent in the education of the child have been wasted from the standpoint of both the child and the State.

The school should so educate the child as to give him the things he needs most up to any given moment. At every stage of the child's development the educational system should be complete and symmetrical up to that point, according to the needs of the child. And as the child develops the educational system should adapt itself accordingly to the changing needs of the child. Each need should be met when it arises. It is not a proper figure to use to say that in the early years of the school course the foundation of the building is laid, and that, as the child grows older, the other parts are added till the building is complete when the child becomes an adult. Rather should we say that at each and every stage of the school course we have built a complete structure, and that in later years the building simply grows larger.

Stressing of the present in education. This stressing of the present life of the child does not mean the neglect of the future, but, on the other hand, it represents the only effective means of preparing for the future. The fulfillment

of the child's present needs is the best possible preparation for whatever later needs may arise. It is like the young apple tree. The first year it is set out it must be given the care that it demands for that particular year and season. Then the second year the care needed for that season must be given, and so on until finally the tree reaches maturity and bears fruit.

This principle is recognized in the care of the child's physical needs. In order that the child may be a strong, healthy adult, we take those steps necessary to keep him healthy as a child. Likewise in the moral field, in order to develop a man with a proper perspective of life who shall perform his duties toward his fellows, the child is taught year by year the moral precepts that he needs for that particular age. And so in the mental life of the child the same principle holds, in order to develop a man who can make the best use of his mind in the part that he is to play in life, we must help the child in each stage of his development to make the best possible use of the mental powers which he possesses at that time.

Motivation through children's problems. The way to secure motivation is to center the school work around the real problems of children. These must have their source in the children's present activities, and must appeal to some interest or fill some real need that the child feels. A sharp distinction should be drawn between children's problems and adult problems. Much attention is being given to the problem method of teaching, but in many cases the problems used are adult problems, and so do not serve to arouse the children's interests. In order that the problem may function in furnishing motivation it is necessary that it should find its fulfillment in the present or immediate future of the child, because the farther away in time the fulfillment is the less it appeals to the children, till no appeal at all is

made if the time is very long. With young children in the primary grades the interest is carried forward only a very short time, while, as the child grows older, the time ahead during which interest may be aroused becomes longer.

External and internal stimuli. The chief value of children's problems lies in the fact that they act as a stimulus to arouse the children's interest. Too often the stimulus that directs the child in school is an external one, imposed from without, in the form of love for or fear of parents or teacher. The real problems of children serve as a natural internal stimulus arising from the child's interests and guiding him to do things because they appeal to him and seem worth while. Successful teaching consists largely in arousing and directing children's interests. After the children are really interested the rest of teaching follows easily and naturally.

The right kind of children's problems is a powerful means of awakening interest, and thus supplying motive power for the work to be done. Children want to do things, not because they are commanded by some one in authority over them, but because they can see some benefit to them from doing a certain thing. And this internal stimulus leads to much more effective and lasting results than the external stimulus. It will make the children aggressive in encouraging self-activity, instead of being mere passive listeners. The external stimulus leads only to temporary results, while the internal leads to permanent results. As soon as the cause of the external stimulus is removed the child's interest is lost and the thing ceases to play any part in his life, but if the stimulus is a true internal motive it stays with the child constantly and guides him, not merely in school, but outside as well.

In seeking to motivate the work of the children the teacher should see to it that the motive is a real one in the

child's life, and not simply a passing interest aroused by the strong personality of the teacher or by skillful methods of teaching. The author has observed strong, vivacious teachers who could sweep along a roomful of children by their enthusiasm, and arouse a temporary interest in the most abstract and meaningless topics. But there was no real inherent motive on the part of the children, and, after the lesson was over, the matter dropped from their minds.

So that in judging teaching it is not enough merely to ascertain whether the children are interested; we must go farther back and seek the cause of this interest. Is there back of it a real child's motive, or is there simply an artificial incentive furnished by the teacher's personality? A teacher who has the power of arousing temporary interest, even in abstract topics foreign to the children's experiences, has a talent for teaching, but how much greater the returns if this talent is turned toward directing children along lines of their natural interests.

Interest and learning. Children's problems are a means of arousing interest, and interest plays a fundamental part in the process of learning. It is necessary for the best development of the child. The child works with greater speed and with more accuracy; facts are remembered longer and more easily. The apparent fatigue of children in the afternoon has been shown to be not a real mental fatigue due to overwork, but to be due simply to lack of interest.

As a result of being guided by these definite purposes the children develop more initiative and independence in their work. This gives the children more enthusiasm for their task, which leads to more vigorous efforts, resulting in greater success. This, in turn, is a powerful incentive for continued endeavor. Thus is the problem of discipline largely solved, because the children are occupied in doing something that appeals to them as being worth while.

Awakening dormant interests. One purpose of science teaching is to arouse new interests in the children. One of the chief reasons why so few people appreciate and enjoy nature is simply because no one has called their attention to the great possibilities of enjoyment to be found here. One of the important purposes of teaching science is to lead the child to see and appreciate some of the great variety of beautiful and interesting things which everywhere abound in nature, but which otherwise remain as a closed book to him.

The children's interest is easily aroused in these subjects. These interests have been lying dormant, merely waiting to be awakened. So that the test of what to teach in science is not merely and only that for which the child already has a feeling of interest or need, but also that for which he can be led to have such a feeling. If the interests thus awakened have their fulfillment in the present or immediate future of the child, his life has been enriched thereby. The interests that we seek to arouse are of this kind, because we wish to lead the child to see and appreciate the things about him. As soon as he sees them, they function at once in his experiences. The reason they have not previously functioned has not been because they were foreign to his interests or because their fulfillment was far in the future; but it has simply been because he has not known of these things in his environment. Thus education should ever seek to broaden and enlarge the child's experiences and to arouse dormant interests of the right kind so that the child may grow.

Elimination. This discussion of motivation leads to one very important conclusion, namely, that only those things should be taught that are useful in some way to the child, and hence have a meaning to him. It is psychologically impossible for a child to have a real motive for doing things

that are meaningless to him. The teacher may arouse a temporary interest in such things, but there is no real motive back of it. This means the elimination of much useless material from the school subjects. It is already being done in arithmetic, grammar, spelling, and other subjects. It should also be done in science. This is especially true of physiology. A large proportion of the time has been devoted to topics that are entirely meaningless to the child, such as most of the anatomy and physiology. Practically all of this should be eliminated and the time devoted to hygiene. In elementary agriculture also much has been taught that is foreign to the child's interests and capacities. The whole field of agriculture needs to be gone over very carefully, with the child's needs and interests in mind, and much material eliminated.

Perhaps the chief elimination in science should come, not so much in the topics studied as in the facts about the topics that are considered and in the observations made. In some cases a topic which in itself is worth while may be chosen for study, but the time may be occupied with many meaningless observations and the real points of interest may be obscured in a mass of detail. These meaningless observations should be eliminated.

Specific motives in teaching science. In concluding this chapter some definite motives that may be used in teaching science may be suggested. Science touches the child's life in so many vital points that there seems little excuse for not properly motivating this subject. It is easily done. Some of these motives may be briefly listed as follows: —

1. Identification of common plants and animals, such as birds, trees, and flowers.
2. Earning money, as in gardening, poultry-keeping, and selling bird-houses.
3. Care of pets and domesticated animals.

4. Competition for prizes, as in gardening and building bird-houses.
5. Making collections, as of seeds, leaves, weeds, flowers, newspaper clippings.
6. Making things, as bird-houses and window-boxes.
7. Games and sports, as skating, coasting, playground apparatus, movies.
8. Study of the operation of machines, as engines, motors, and automobiles.

CHAPTER V

METHODS OF TEACHING SCIENCE

In order to procure proper motivation it is suggested that the three following points be considered by the teacher in planning her lessons: first, the child's problem; second, the development of the lesson; and third, the application. The most important thing is the child's problem, because this is the center that determines the development of the lesson and its application.

Value of a problem. In the previous chapter the value of the child's problem in arousing interest and motivating the work was shown. The problem will also be a great help to the teacher as she plans her lesson, both in selecting and in organizing the subject-matter.

It also serves as a guide during the lesson for both teacher and children, in determining what shall be included in the lesson. Many times when the lesson is begun without any definite purpose on the part of the children, some little incident may deflect the discussion entirely away from that which the teacher had in mind to accomplish, and she is perplexed to know how to direct the lesson back to the desired end. With a definite problem before the children this difficulty is solved, because the problem is a constant guide. If the recitation is getting away from the problem, mere calling attention to it will enable the children themselves to determine whether the points under discussion relate to the problem; and if not, the children may orient themselves. It thus serves as a guide to both children and teacher.

One of the chief values of the problem lies in the fact that

it permits so much of the initiative for what is being done to come from the child. The child's problem, and not the teacher, is the determining factor.

Lack of a problem in teaching illustrated. As a definite illustration of the aid that a child's problem gives the teacher in selecting and organizing material, and gives both teacher and children in guiding the lesson, we will take a lesson on a maple tree. If the teacher is to give a lesson on this topic, and has no definite problem in mind, she does not know what points to take up. The whole discussion is confused and indefinite. Not having any definite purpose to accomplish the teacher does not know when the lesson has ended.

Many insignificant details may be observed about the leaf, such as length of petiole, color of petiole, length and breadth of leaf, number of points or lobes on the margin, color of upper and lower surfaces, general shape, roughness and hairiness of surfaces, number and arrangement of veins, and so on indefinitely, observing petty points, most of which have no significance to the child. The points that do have meaning to him are buried in such a mass of detail that he does not see their significance. Anything about the tree may be considered, the lesson may be extended to any length of time, there is no special reason why the maple tree should be studied, and no use of the knowledge gained is called for.

Value of a problem in teaching illustrated. But how different the situation becomes when we start with a definite problem like the following: "We will study the maple tree so that we can tell it from the elm tree as we see it growing." Now the points to be taken up stand out sharply; they are the differences between the maple tree and the elm tree. If the lesson is an indoor one, the leaves may be studied to note their differences in shape, margin, veining, etc.; like-

wise for the features seen only outdoors, differences in the shape and method of branching of the trees. All these points, otherwise disconnected, fall into a regular orderly series, and thus the problem helps not only in the selection, but in the arrangement of material as well. Large groups of differences stand out first; such as differences in leaves, in fruit, in bark; then each of these has its subdivisions.

Thus this definite problem serves as a central thought for the whole lesson, a definite aim toward which all may work, and as a result they know when they have reached the goal and the purpose of the lesson has been accomplished. And the statement of the problem suggests in itself the use to be made of the knowledge gained, namely, to find the two trees growing and to distinguish them.

Can any one doubt what the difference will be between these two lessons in the attitude of both teacher and children and in the interest shown? One has but to visit schoolrooms and observe the two types of lessons, one aimless, the other definitely motivated, to be thoroughly convinced of the vast gulf that separates these two methods of teaching.

In order that a problem may accomplish its purpose of arousing the interest of the child, it must be very definite and specific. Broad general purposes such as the teacher may have in mind make little appeal to the child. His problem must be one that is possible of immediate fulfillment.

Presenting problem to children. If the problem is to serve as the guide and motive power for the lesson, it is self-evident that the first step of the teacher is to get the problem clearly before the children, and to show the relation between the work to be done and the end that the child seeks. In bringing the problem before the children use should be made of the principle of apperception. The knowl-

edge which the children already possess regarding the problem or some topic related to it should be brought out by questioning, and then the problem should be presented to the children. The skillful introduction to the problem plays an important part in arousing the interest of the children in the problem itself. The problem must be clearly shown to be related to the children's experiences, to something regarding which they already have some knowledge. The child has no interest in what is absolutely foreign to his experiences.

Development. The development should be so planned as to answer the question raised in the problem. Enough points should be included to answer the question satisfactorily, and those points which have no bearing on the problem should be omitted. Here is where the matter of elimination comes in, eliminating, not the whole topic, but those phases of the topic which have no meaning for the problem involved.

After those points have been selected which are needed to solve the problem, the next matter to consider is the organization of this material. This means first putting together in large groups those things that naturally belong together, and then, secondly, making the proper subdivisions of each group. And, finally, there is the matter of sequence, as to which point shall come first and which last. This organization should be made from the standpoint of the child and not from that of the adult. In those problems which involve some manual activity, such as gardening and building bird-houses, the most natural sequence from the child's standpoint is the order in which the various things are actually done, those which are done first being considered first, and so on till the last step is reached. The child's problem will prove a great help in organizing the subject-matter.

Application. The final step comes in the application or use of what the child has learned. The use of knowledge is the chief end of education. A lesson without application means wasted effort. One of the vital things in planning a science lesson is to consider how the children may be encouraged to make use of what they have learned. If the problem does not seem to allow of any application, we may well inquire whether the problem is really worth while. And, indeed, the best kind of problem suggests the application, because it is the possibility suggested by the problem of helping the child do something which he wants to do that furnishes the main element in motivation.

The word "application" is used in a very broad sense to include any use of knowledge that has any worth to the child; it may be in deriving greater pleasure in life, or it may be in aiding him better to perform his home duties. Knowledge is useful when it helps in any way to make life more worth living.

During the lesson the teacher should suggest ways in which the children may make use of what they have learned, and do what she can to encourage it. The children may be asked to do certain things, and at the beginning of each science lesson opportunity may be given for them to report on their observations. This method may be used frequently in the effort to awaken dormant interests in nature. If the children are asked and expected to make these applications, and opportunities are given for reporting to the teacher or class, this will serve as an additional stimulus. It will be found that the number of children who report on their observations may be gradually increased by constant encouragement.

Following are suggested some ways in which application may be made: (1) actually doing things suggested in the lesson, as in planting a home garden, destroying insect pests

and weeds, building nesting-boxes for birds, planting trees, helping parents at home, forming hygienic habits; (2) watching others doing the things studied, as the farmer and gardener ploughing their fields or harvesting their crops; (3) making outdoor observations on the topics studied, such as flowers, trees, birds, and insects in their natural environment, and observations of the structure and working of common applications of science, such as the automobile and telephone; (4) bringing specimens to school to show the children's ability to identify the form studied, such as flowers, weeds, and leaves of trees; (5) making collections, such as weed seeds, woods, nests, woody mushrooms, flowers, leaves of trees, ferns, and insects; (6) talking over with the parents at home the topic studied; (7) cutting out clippings from newspapers and magazines relating to the topic under consideration.

A few suggestions regarding the working-out of the various parts of a lesson plan are summarized below in brief outline form.

Summarized Suggestions for Lesson Plan

A. Introduction to child's problem.

1. The introduction to the child's problem should deal with the children's experiences.
2. It should be appropriate to the problem.

B. Statement of child's problem.

1. The child's problem should relate to those things for which the child already has a feeling of interest or need, or for which he can be led to have such a feeling.
2. It should find its basis in the child's present life, or in that of his immediate future.
3. It should be worth while.
4. It should be definite.
5. It should deal with only one main thought.
6. It should be clearly stated in children's language.

C. Development.

1. All points included in the development should relate to the problem.
2. Enough points should be included to answer the problem.
3. The development should be well organized with reference to the problem.
4. Provision should be made for summarizing the essential points.

D. Application.

1. The application should be the doing of something which interests the child and which can be done naturally in his ordinary life.
2. It should suggest the doing of only a few things, preferably of only one thing.
3. It should be stated clearly and with sufficient detail so that the child understands what he is to do.

As a definite illustration of these suggestions the following lesson is given for a third grade: —

An Illustrative Third-Grade Lesson

I. Topic: Elm and maple tree.
II. Grade: Third.
III. Season: Fall or spring.
IV. Materials: A maple and elm leaf for each child; a cluster of elm and maple leaves showing arrangement.
V. The Lesson.

A. Child's problem.

1. Introduction to child's problem.

How many children have trees in your yard at home? How many different kinds have you? Have you noticed how many kinds of trees there are in our school yard? Would you like to know the names of these trees so that you can call them by their names as you do your friends? The trees growng in our yard are the elm and the maple.

2. Statement of child's problem.

I have here some leaves from these trees, and we will study them to see how they differ, so that we can tell the elm from the maple tree by means of their leaves.

B. Development.

Outline of points	*Questions*
1. Shape of leaf	What differences do you find in these leaves? How are they different in shape? Several may go to the board and make a drawing of each leaf, and we will ask the class to decide which shows the shape best.
2. Size	Is there any difference in the size?
3. Margin	Are the edges alike? Make a drawing on the board of the edges of the two leaves.
4. Veining	Do the veins run in the same way in both leaves? Can some one make a drawing to show the difference?
5. Arrangement	Look at these clusters I have here and see if the leaves are placed the same on both trees. Which do you think is the surest way to tell these leaves apart?

C. Application.

When school is dimissed you may look carefully at the leaves of the trees in the school yard and find a maple tree and an elm tree. Bring in a leaf from each tree. To-morrow I will ask each of you to tell the class exactly where these two trees are. When the leaves begin to change color, we will watch these two trees and see if their leaves turn the same color.

D. Correlated work.

1. Art.

A few children may be asked to make drawings of the leaves on the board, and besides this, at the close of the lesson, each child may make a free-hand outline drawing of each leaf with pencil, or a mass drawing may be made with green crayons. Free-hand cuttings may be made, then colored with crayons. Blue prints of the leaves side by side may be made.

2. Literature.

After the lesson on the trees has been given, some of the following literature may be read to the children: —

Lovejoy, *Nature in Verse*, page 203.

Stone and Fickett, *Trees in Poetry and Prose*, pages 25–39; 81–93.

Wait and Leanard, *Among Flowers and Trees with the Poets*, pages 286; 297–300.

In the development the outline suggests the main points to be brought out that will help to solve the child's problem. The exact questions to be asked cannot be definitely planned beforehand. It is better to ask a few leading questions than many minor ones. The question involved in the statement of the problem, "What differences do you find in these leaves?" would be sufficient to bring out most of the points in the lesson. After the children have exhausted their answers to this question, if some other points of difference have been overlooked the teacher may then ask other questions to direct the children's attention to these points. The questions given in this lesson are intended for this purpose in case some point is overlooked. It is not expected that it will be necessary actually to ask all these questions.

Place of observation in teaching science. The abandonment of the old faculty psychology, and the very radical modification of the theory of formal discipline now generally accepted, must have an important bearing on aims and methods of teaching science. We can no longer entertain the idea that there is a general power of observation which can be trained by observing anything, and that this power, once trained, can then be turned to use in any field. The power of observation is specific. Instead of being content to allow the child to observe any material that may be available, we must direct the child to observe those things which in themselves are worth observing on account of the relation which they bear to his life. If there seem to be in nature some things which the child should observe, then specific training in the observations of these particular objects should be given.

Thus, in the first place, a very careful selection of topics is necessary. Furthermore, having decided on the objects worth observing, it will not suffice merely to have the child observe anything and everything about the object in question, but he should be led to observe those features which are worth observing. Thus, there is necessitated not only a careful selection of topics, but also a careful selection of the line of observation to be followed.

The relation which these things bear to the child's life may be taken as the basis for this selection. The child should see that the work is related to something that interests him, and so is worth while. The observation should be guided by specific, clear-cut problems within the child's comprehension, which in themselves suggest and limit the points to be studied. The amount of observation called for will depend upon the nature of the problem. In some cases it may be an important factor; in others it may play but a minor part.

Elimination of worthless observation. Just at the present time one of the needs in science teaching is the elimination of much worthless observation of insignificant details that have no meaning. For instance, one type of lesson is to take some material, such as a flower, and have the children make all possible observations on it without any special purpose, except that the children see all they can about the flower. This seems to be a sort of simplified form of the analysis blanks formerly used so much in high-school botany, on which were recorded in tiresome details a great mass of meaningless observations.

Observation for its own sake cannot be justified as an aim of science teaching. This narrow conception has helped to bring the subject into disrepute, and has sometimes been the cause of an apparent conflict between agriculture and nature-study. Observation is not an end in itself, but

simply a means to an end. The introduction of this new method of study was such a radical departure from the method in common use that it is not to be wondered at that for a while undue emphasis was laid upon it. It should now be given its proper place as secondary to, and controlled by, some large aim expressed in terms that interest the child.

The effect of applying the suggestions here given might seem to lessen the importance attached to observation, but it would give a more rational and symmetrical perspective to the whole subject of science. Too often the work in science has consisted merely of aimless observation alone, and the work has stopped there, whereas this should be but the starting-point. Observation is simply a means of gathering the raw material which is to be used, and the chief value of observation consists in the fact that it constitutes an effective way of gathering this material, quite different from the book method used in most school subjects. But the work should be organized around a vital problem and carried through to some real issue. A science lesson which consists of observation alone may be quite as deficient as one in which observation forms no part. It is not the writer's intention to minimize the value of observation, but simply to attempt to point out its true place, and to hint at some of the larger and more vital problems which are possible in teaching science.

PART II
BIOLOGICAL SCIENCE

CHAPTER VI

TEACHING CHILDREN ABOUT BIRDS

Motivation of bird-study. Bird-study is a topic that is easily and naturally motivated. Birds are a common and noticeable form of life in the child's environment. One of the first motives appealed to is the desire to know the names of these common birds. The identification of birds may form an important part of the work in the primary grades. The bright colors of many of our birds and the activities of bird life make a combination that appeals strongly to children. After a child has once begun to notice bird life the interest naturally grows.

The manual activities involved in building bird-houses are other features that appeal to children. The older children are interested in the practical value that birds are to man, so that their economic value may be studied in the upper grades. Children of all ages are interested in the formation of bird clubs for the study and protection of birds. They are interested in reporting observations they have made on birds. A spring calendar is an excellent means for stimulating these observations. The teacher should encourage these observations and give opportunities for reports to be made to the class. In the autumn a collection of nests may be made for the school. Many of the lessons taught in the schoolroom may furnish topics for conversation at home. The older children may be encouraged to cut out clippings relating to birds from magazines and papers, and to bring them to school to put on a bulletin board.

Materials for bird-study. The best and final thing for the child to study is the living bird outdoors. For the schoolroom lessons some material is needed to create an interest which shall lead the child to this outdoor study. In most schools mounted birds cannot be obtained, and it is questionable whether these would be desirable, especially for young children. As an introduction to bird-study sometimes it may be possible to keep a pet canary in the schoolroom for a few days.

Pictures. There is a substitute for mounted birds that can be used, which serves the purpose exceptionally well, namely, colored pictures. Very good pictures can now be obtained from the following sources: —

1. National Association of Audubon Societies,
   1974 Broadway, New York City.

   About ninety pictures have been published, to which six are being added each year. The price is two cents apiece, including, besides the picture, an outline drawing and a four-page pamphlet descriptive of the bird's habits. On application to the above address a list of pictures for sale will be furnished. The Association has recently published the Audubon pocket bird collection. This is a folded card, about nine by seven inches, containing small colored pictures of birds. It is easily carried in the field and makes a ready means of naming birds. Case number 1 contains sixty-three pictures of winter birds of the Eastern United States. Case number 2 contains eighty-two pictures of birds common in the Southeastern States. Case number 3 contains seventy-four figures of March and April migrants of Eastern United States. Case number 4 contains eighty-four figures of the common winter birds of the Western United States. The price is ten cents for each case.

2. G. P. Browne Company,
   Beverly, Massachusetts.
   About three hundred and fifty pictures have been published. The price is two cents each. These may be obtained on light-weight mounts for four cents each.
3. Massachusetts Audubon Society,
   66 Newbury Street, Boston.
   This society sells pictures mounted as charts. There are three charts, known as the "Audubon Bird Charts," twenty-seven by forty-two inches, arranged so that they can be hung in the schoolroom. Charts Numbers 1 and 2 each contain twenty-six common birds, and Chart Number 3, twenty winter birds. The price of each chart is $1.50.
4. The Bureau of Biological Survey has issued a large poster on the feeding of winter birds. This may be obtained free on application to the Bureau at Washington, D.C.

Hand work. For young children it is important that a large amount of hand work should be provided, as children acquire knowledge faster by this means. Colored pictures furnish material for this kind of work. The children are given outlines and, with the colored pictures before them, color in the outline, using either colored crayons or water-colors. The outlines may be obtained in two ways: first, the teacher, by means of a mimeograph or other device, may make enough outlines to supply the class; second, the children may make the outlines themselves. The older children may make free-hand drawings of the outline from the picture.

The younger children may trace the outlines. For this purpose two grades of paper are needed, the ordinary drawing-paper on which the final outline is to be colored, and some paper thin enough for tracing; thin typewriting

paper will do. The paper is held over the picture and the outline of the bird traced. When this is finished it is turned over and placed on the ordinary drawing-paper with the outline next to it. The child takes his pencil and marks back and forth a number of times across the paper, just over the outline already drawn. This causes enough of the pencil mark to be rubbed off to reproduce the outline on the second paper. The child may go over this outline with a pencil to make it clear, and then color it. Free-hand outlines of birds may be cut from paper or cardboard, and then colored on both sides with crayons. These may be suspended by means of thread to represent flying birds.

The purpose of this work is to enable the children to identify the birds in the field more easily, because they have noted the colors and their location, and they should be encouraged to look for these birds. If this hand work stops in the schoolroom without leading to the study of birds outdoors, it may be questioned whether it is worth while.

Bird calendar. A spring bird calendar is a source of never-failing interest, beginning even with the very youngest children and extending up through the grades. A calendar may best be kept on a large piece of heavy paper or cardboard. At the top should be some artistic decoration appropriate to the subject. For the young children the reports may be arranged in four columns: —

Name of bird	*Name of child first reporting*	*Date first seen*	*Where seen*

For the older children the following columns may be added: —

Date when abundant	*Date when nesting*	*Remarks*

The competitive element suggested in having the child's name appear on the calendar stimulates the children and arouses much interest. Several precautions will need to be observed by the teacher. Children will often report very positively the appearance of a bird a month before it is due to arrive. If the teacher has access to a local calendar kept by some bird-student, it will help her in knowing when to expect certain birds. The migration dates for several localities in the Eastern United States are given in Chapman's *Handbook of Birds*. If the children report birds several weeks ahead of the dates given on some reliable migration record, probably they have made a mistake, and they should be told so by the teacher.

After it is probable that the bird has arrived, it must be understood by the class that no bird's name is to go down on the calender till the child has given such a good description of the bird that there is no doubt about its being seen. In case of doubt the name should not be put down.

Bird games. The game element may profitably be introduced into bird-study, especially with young children. Following are some games which the author has seen used that help the child in describing and identifying birds: —

Games with colored pictures. Game Number 1. The teacher shows the pictures one at a time to the children, keeping the name covered. The child who first correctly names the bird takes the picture. The child who has the most pictures at the end of the game wins.

Game Number 2. This may be used with older children.

A large number of pictures are hung around the room and numbered, the names being covered. Each child writes the list of numbers on a piece of paper, and opposite the number the name of the bird. The child who names the most wins.

Game Number 3. The teacher pins the picture of some bird on a child's back and shows the picture to the class. The child stands before the class and asks questions of any one he wishes about the bird, till he guesses it correctly. He then names some one else to take his place.

Game Number 4. The pictures are placed on a table or stood on the blackboard railing, with the names covered. The children are asked in turn to pick out the picture of a certain bird. The child who picks out the most correctly wins.

Game Number 5. A child stands before the class with a collection of pictures, the names being covered. He names them one at a time till he makes a mistake. The child who first corrects the mistake then takes his turn in naming the pictures.

Game Number 6. The names of birds are written on separate slips of paper, and these are placed on the edge of the blackboard. The pictures of the birds are placed on the table with the names covered. The children are asked to pick out a picture and place it beside its name. The purpose of the game is to see which child can match the largest number of pictures and slips.

Games without pictures. Game Number 7. A child stands before the class and describes some bird which he has in mind. The children try to guess the bird from the description. The child who first guesses it correctly then begins the description of another bird.

Game Number 8. This is a slight modification of the previous game. A child stands before the class and has some particular bird in mind. The children take turns in

asking questions about the bird, its color, size, etc., till some one guesses the bird. This child then takes his turn in answering questions about some other bird.

Dramatization. Children enjoy dramatization and learn much thereby. Some simple bird play could easily be arranged and the parts taken by the children. The Liberty Bell Bird Club has arranged three plays: *The Workers*, *The Bird's Return*, and *The Birds' House-Hunting*, which may be obtained of the *Farm Journal*, Philadelphia, for three two-cent stamps each. Probably Percy MacKaye's *Sanctuary* could be adapted for grammar grades.

Bird clubs. Much enthusiasm can be aroused by the organization of bird clubs. A local bird club can be formed anywhere, but more interest will be aroused if this is formed in connection with some large organization. There are at least two ways in which this can be done. One is through the National Association of Audubon Societies. Each child who wishes to join pays ten cents. The names are sent by the teacher to New York City to the Association at 1974 Broadway. Each child receives in return eight colored bird pictures, the Audubon pocket bird collection, and an Audubon button, which has on it a picture of the robin and the words "Audubon Society." If there are fifteen or more members, the teacher receives *Bird-Lore* for one year.

Another means is through the Liberty Bell Bird Club of the *Farm Journal*, Philadelphia. The following pledge is written at the top of a sheet of paper, and the children who wish to join write their names under this pledge: "I desire to become a member of the Liberty Bell Bird Club, and promise to study and protect all song and insectivorous birds and to do what I can for the club."

This list is sent to the *Farm Journal* at Philadelphia. Each child in return receives a little pamphlet, entitled,

Guide of the Liberty Bell Bird Club; he also receives a bird button, which has on it a picture of a swallow and of the Liberty Bell, and printed across it the motto, "Protect Our Feathered Friends," and around the circumference, "The Liberty Bell Bird Club."

The advantage of the first club is that each child receives pictures and leaflets which may be used in connection with the meetings of the club. The advantage of the second club is that no money is required. The teacher can select whichever seems best suited to the locality where she is teaching. Except with the very young children it is well to elect officers and to allow the children to assume the chief responsibility for the work of the club under the supervision of the teacher.

There is a great variety of things that may be done at the meetings of the club. If the colored plates are used the children may color some of the outlines. Any one of these birds may be taken as the topic of the meeting, and the pamphlet and other references studied in preparation, different children being assigned topics to look up. About a week before the meeting the bird to be studied should be announced, so that the children may be watching the birds outdoors and report what they have seen. A meeting may be held to discuss the making of bird-houses, and at another meeting these may be brought together and compared. A number of field trips should be taken to study the birds out of doors. All of the above can best be done in the spring. In the autumn nests may be collected and studied. In the winter the subject of winter feeding may be taken up.

What bird clubs may do. From a number of letters published in *Bird-Lore* explaining about the work of the clubs, the following list is taken of the things which were done by the various clubs: —

Prizes offered for the following: —

Best bird-houses, greatest number of bird-houses for different birds, longest list of birds identified from pictures, best bird records, best composition showing intimate knowledge of birds, best colored drawing of some bird, prize to the school or room having the largest number of clippings in their bird-clipping book.

Making bird-houses, feeding devices, and fountains for the home yard.

Building bird-houses to put up in school yard.

Exhibition of bird-houses open to the public.

Members of clubs give talks to children in other buildings.

Demonstration of tying suet to branches of trees.

Debates on such questions as, "Should the crow be protected?"

Providing Christmas trees for the birds.

Field trips.

Publication of a paper containing articles about birds.

Playing bird games.

Spring migration records of birds kept by club.

Attending illustrated lecture given by some one who has lantern slides.

Meetings of bird clubs. The following are the suggestions for meetings as given in the *Guide of the Liberty Bell Bird Club:* —

First. Repeat in concert the pledge of the Liberty Bell Bird Club.

Second. Members report all the different varieties of birds seen since the last meeting. This report to be written, read, and given to the teacher or director and to be filed.

Third. Recitation or reading — a bird poem or a bird story. Many good ones appear from time to time in the *Farm Journal's* Bird Club page and elsewhere in the paper.

Fourth. Members report what they have observed, and all special bird work done by them.

Fifth. Composition on one of the articles in the Bird Club page of the *Farm Journal.* Subject to be given by the teacher or director.

Sixth. Question Box.

Seventh. Work outlined by teacher or director for the following week.
Eighth. Adjournment.

In many cases enough interest is aroused so that the members of the club meet during the summer vacation at the homes of the members.

The child's activities. One of the most effective phases of nature-study is that which calls into play the manual activities of the child in providing opportunities himself for making a study of the life about him. Bird-study is especially well adapted to make use of these activities in building nesting-houses, in feeding the winter birds, and in providing fountains. The very fact that the child is doing something for the birds is a means of developing that helpful sympathy with nature which may prove such an important factor in all his subsequent life. And, furthermore, excellent opportunity is given for watching the birds that may come in response to the attractions offered. These observations will be carried on with much greater ardor and thoroughness because the child has himself helped to furnish the conditions which make his observations possible.

Nesting-houses. Perhaps there is no one line of work that interests the children so much as the making of bird-houses, especially in the primary and intermediate grades. Even very young children are interested, and when they are too small to make the houses themselves, some one of the family at home may help them. The houses can be built at home or in the manual-training department. Children may be asked to bring materials, and then some one may help them in the manual-training shops. Many children will be interested to the point where they will make houses at home. As an added incentive they may be asked to bring their houses to school on a certain day, so that a picture of

the children with their houses may be taken. The problems which arise in connection with the construction and location of bird-houses should be talked over with the children and the important precautions to be observed explained to them. The really essential features having been made clear, the children should be allowed to use their ingenuity and individuality about arranging details.

If the school building is favorably situated, houses may be put up in the school yard. If these are occupied opportunity will be given the school for bird-study at close range. It would be well worth while to see if the park boards would not coöperate with the schools, so that the children might make bird-houses and place them in the parks. Such a plan was carried out in Jackson and Washington Parks, Chicago, where the children made several hundred wren and blue bird houses.

Difficulties. The children should understand the difficulties to be met, so as to avoid undue disappointment, and should be prepared to overcome them as far as possible. The greatest obstacle of all is the English sparrow. One of the most effective devices for keeping this bird out of the nesting-boxes is to make the hole so small that the sparrows cannot enter, but large enough for the wren and the chickadee. With houses for blue birds and tree swallows, probably the most effective thing which the children can do is to make the houses so that the tops can be easily lifted, and then to remove the sparrows' eggs once a week or as fast as they are laid. This often causes the sparrows to leave the nesting-house. If nothing else can be done the entrance can be covered or the house taken down as soon as it is evident that no other bird is going to use it. This will prevent the sparrows from rearing their young. Of course, killing the sparrows cannot be recommended to children. Whatever is done along this line must be left to adults.

Feeding the winter birds. The introductory work of feeding the winter birds should be done in the late fall. A talk on the food of birds may be given, so as to bring out the two classes of foods, animal and vegetable. The kinds of food to put out and the methods of putting it out may be discussed. The necessity of providing a constant supply of food should be emphasized, and also of seeing that there is a good supply immediately after a snowstorm. The children may occasionally be reminded of the feeding so that they will not neglect it too long. The possibility of taming the birds to feed from the hand should be brought to the children's attention. The construction of winter-feeding devices may be made a part of the manual-training work. While the children are being encouraged to feed the birds at home, a lunch-counter may be provided in the school yard, if the conditions will allow it. Committees may be appointed among the children to see that the counter is provided with food.

Field trips. There is but one way to know the birds, and that is to study them in the field. In the schoolroom the children may be prepared for field studies, and may learn about the value of the birds and how to protect them, but without a knowledge of the birds themselves enthusiasm will be lacking.

The ordinary class of thirty to forty children is too large for the teacher to attempt a field trip with them all, but frequently some arrangement may be made with the principal by which half of the class may be taken at one time. Sometimes walks may be taken with a few children who are especially interested.

Both teacher and children should start out with a very definite purpose in mind. The teacher should prepare and plan for the trip very carefully. One purpose may be to see how many kinds of birds can be identified, and to make a

list of them. Another purpose may be to make a special study of one or two kinds of birds, noting the size, general colors, song, nesting-habits, and methods of locomotion.

Whether field trips with the children are taken or not, the teacher should constantly encourage the children, when by themselves as they pass to and from school and when at home, to study the birds and report their observations to the class.

One of the chief purposes of the field trips taken by the teacher with the children is to stimulate them to observe birds when by themselves.

Bird Day. Bird Day is observed often in connection with Arbor Day. Bird Day is now officially recognized in nine States. In observing this day one special feature to be emphasized is doing something for the birds, such as putting up houses at home or in the school yard. The program should not be so formal as to obliterate this important feature.

The following are suggestions for a few general lines of work that may be carried on: —

1. Reading of proclamation.
2. Talk by some one outside of the schools.
3. Talk by teacher.
4. Original essays by children.
5. Reports on outdoor observations.
6. Recitations and readings.
7. Dramatic presentation.
8. Songs.
9. Putting up bird-houses and planting shrubs in school yard to attract birds.

Correlation with other subjects. Bird-study may do much to aid other lines of school work and may also itself be made more interesting by proper correlation. Many opportunities present themselves in connection with several

subjects, especially with art and literature. The children may make outlines of birds and color them, as explained in previous pages, and the older children may paint the birds free-hand with water-colors. The children may help make artistic decorations for the bird calendar. A large amount of splendid literature has been written, and this should form an important part of the work with birds.

Arithmetic and bird-study. Some problems in arithmetic relating to the number of insects eaten by birds, the number of birds, and other topics may be given the children. A few are here suggested: —

A. Problems on the number of insects eaten by nestlings.

1. A pair of wrens were observed to feed their young 17 times in an hour. The parents fed their young from 5 A.M. till 8 P.M., and the young remained in the nest 15 days. Assuming that one insect was brought at each visit, how many insects were destroyed by this brood of wrens?
2. Many birds on the average feed their young about 200 times a day, and the young stay in the nest about two weeks. After the leaves have fallen, count the number of nests in a certain area and then estimate the number of insects that have been destroyed by the birds reared in these nests, assuming one insect brought at each feeding.

B. Problems on amount of food eaten by adult birds.

1. A study made of owls during the winter months showed that they destroyed 2 mice a day. It has been estimated that each mouse does damage to the extent of 2 cents each year. How much is an owl worth a year?
2. A study made by the Biological Survey of the red-shouldered hawk showed that out of 214 birds, 3 had eaten poultry and 102 had eaten mice. What per cent of the birds had eaten poultry and what per cent mice?

C. Problems on the number of birds.

1. A census made of birds in the eastern United States showed that there was an average of 6 pairs of robins to each farm of 58 acres. There are about 4,000,000 farms east of the Mississippi, averaging 93 acres each. How

many robins are there on the farms east of the Mississippi River?

2. This census also showed that for every 100 robins there were 83 English sparrows, 49 catbirds, 37 brown thrashers, 28 house wrens, 27 kingbirds, and 26 bluebirds. How many individuals of each kind of birds are there on the farms east of the Mississippi River?
3. This census also showed that there was an average of one pair of birds per acre. How many birds are there altogether on the farms east of the Mississippi River?

D. Problems on migration.

1. The robin as a species travels from Iowa to Alaska, a distance of 3000 miles, in 78 days. How many miles does the robin average to travel in a day?

E. Miscellaneous problems.

1. A study of hawks made by the United States Department of Agriculture showed that 5 kinds were harmful, 7 kinds were neutral, and 35 kinds were beneficial. What per cent of the hawks respectively are harmful, neutral, and beneficial?

Seasons and grades. Most of the bird work should be done in the spring, excepting a few lessons in the winter on winter birds and their feeding. There is something of interest about birds for every grade. The younger children are interested especially in the bright colors and in learning the names of birds. The children in the intermediate grades are interested in the same things, but in addition they show a great interest in the manual activities involved in building bird-houses. They begin to show some appreciation of the economic value of birds. In the grammar grades this economic aspect may be strongly emphasized together with the subject of bird protection.

The following brief outline suggests the distribution of a few topics according to grades and seasons. More detailed suggestions are given in the outline in Chapter XIX: —

Season	*Primary grades*	*Intermediate grades*	*Grammar grades*
Autumn		Nest census	Game birds Fall migration
Winter		Feeding birds	Hawks and owls Economic value of birds
Spring	Study of a few brightly colored birds Calendar	Nesting-boxes Bird club Nesting-habits Calendar Recognition of common birds	Bird enemies Bird protection Bird songs Bird migration Study of common birds not taken in lower grades

Series of lessons on birds. The three groups of lessons here given are type lessons for the primary, intermediate, and grammar grades, and are illustrative of what may be done by teachers.

A. Lessons for primary grades

TOPIC: THE BLUEBIRD (SPRING)

Materials: Colored picture of a bluebird.

Child's problem.

How can we tell the bluebird when we see it?

Outline of development.

1. Color.
   - A, on back.
   - B, on breast.
2. Size.

Application.

Ask the children to watch for a bluebird, and report to the class the first one they see.

Correlated work.

Art. Have the children color outline of bluebird.

Literature.

Wiggin and Smith, *Posy Ring*, page 68.

Wright, *Gray Lady and the Birds*, page 318.

TOPIC: WREN'S HOUSE (SPRING)

Materials: Picture of house wren, wren's nest, several types of wren houses.

Child's problem.

We will learn to-day what kind of a house we should make for a pair of wrens to nest in.

Outline of development.

1. Kinds of material to use.
2. Size of house.
3. Shape of house.
4. Entrance hole.
   - A. Size.
   - B. Shape.
   - C. Location.
5. Provision for fastening.

Application.

Ask the children to make a bird-house at home and then bring it to school so all can see it, and a picture may be taken of the children with their bird-houses. If the children cannot make the house themselves, they may be asked to bring materials to school where the teacher or older children will help them.

B. Lessons for intermediate grades

TOPIC: THE WINTER BIRDS

Materials: Samples of food that may be used, such as grains, nuts, etc.; a few simple feeding devices, such as shelves, hoppers, and a suet basket.

Child's problem.

How can we help the birds this winter?

Outline of development.

1. Kinds of food.
2. Methods of putting it out.
3. Birds that may come.
4. Taming birds to feed from hand.

Application.

Have a feeding-station put in the school yard and food provided by children. Encourage children to feed the birds at their homes and to report the results.

Correlated work.

Manual Training.

Have the children in the manual-training department make various feeding-devices, such as suet-baskets, shelves, hoppers, moving counters, and a large feedery for the school yard.

Literature.

McMurry and Cook, *Songs of Tree-Top and Meadow*, page 130.
Lovejoy, *Nature in Verse*, pages 272, 273.
Lovejoy, *Poetry of the Seasons*, pages 278, 290, 317, 318.
Wright, *Gray Lady and the Birds*, pages 27, 131, 187, 293, 300, 301, 355.

Topic: Identification of Birds (A Review Lesson)

Child's problem.

What are the most common colors found on birds by which we may identify them?

Write on the board a list of all the birds the children know. Then put the following table on the board and have the children fill in the names of the birds in the proper columns: —

Birds marked with					
Red	*Blue*	*Yellow*	*Brown*	*Black*	*Gray*

Topic: Work of the Audubon Societies

Materials: Samples of the leaflets published by the Audubon Societies; a November-December issue of *Bird-Lore*, which contains the annual report of the National Association of Audubon societies.

Child's problem.

What are the Audubon Societies doing to protect birds?

Outline of development.

1. Legislation.
2. Wardens.

3. Lecturers.
4. Bird reservations.
5. Publications.
6. Junior Audubon Societies.

Application.
Have the children form a Junior Audubon Class to help protect the birds.

C. Lessons for the grammar grades

Topic: Hawks and Owls

Materials: Pictures of hawks and owls and of the animals they eat.

Child's problem.
Should hawks and owls be protected?

Outline of development.
1. Beneficial species.
2. Neutral species.
3. Harmful species.

Application.
Have the children look up the State Law to see which hawks and owls are protected. Have the papers watched and clippings made.

Correlated work.
Literature.
Burroughs, *Songs of Nature*, page 31.
Lovejoy, *Nature in Verse*, page 232.
Ingpen, *One Thousand Poems for Children*, page 229.
Wright, *Gray Lady and the Birds*, pages 164, 170.

Topic: Work of the National Government in protecting Birds

Materials: Sample of bulletin published by the Bureau of Biological Survey, map showing location of bird reservations, copy of the Migratory Bird Law.

Child's problem.
What is the National Government doing to protect birds?

Outline of development.

1. Work of the Bureau of Biological Survey.
2. Bird reservations.
3. Law protecting migratory birds.
4. Tariff restrictions on feathers.

Application.

Ask the children to watch the papers for items concerning any of the above, especially number 3, and bring the clippings to class.

CHAPTER VII

TEACHING CHILDREN ABOUT INSECTS

Motivation. Children need a series of specific aims that shall serve to motivate their work. These aims must be sought in the part that insects play in the child's life. Insects are the most abundant form of life in the child's environment. He sees them at every turn. His first interest then is to become familiar with a few of the common forms, and to learn something of their life activities, how they eat, breathe, and move. Another point of contact is through flowers. He is naturally curious to know what the insects are doing there.

The child's gardening experiences form another avenue of approach. A great variety of insects are found in the garden. The child wishes to know what relation these insects bear to his garden. In some cases he can see the harm they do, and he wishes to know how to control them. In the case of beneficial insects the relation is not so self-evident. And then finally such pests as the fly and the mosquito are abundant everywhere, and the child is interested to know the harm they do and what he can do to control them.

The thought of using what one learns is a very important factor in motivation. The best kind of problem is one which from its very nature suggests the doing of something. The application for the study of common insects and their activities is to find these insects and observe them in their natural environment. The application of studies of injurious insects is to observe their activities and the harm done and to apply the remedies to control them. If a child is too

young to take an active part in the work against injurious insects, he may observe what other people are doing. The application of the study of beneficial insects is to recognize some of the more common forms when one sees them, and to observe the good they do.

The children may make collections of those insects which are shown to bear a close relation to their life. The home and school life may be brought together by having the child talk over these topics at home. The older pupils may watch newspapers and magazines for clippings regarding insects.

Materials (cages for living insects). Living insects are easily kept in the schoolroom in some simple apparatus provided for this purpose. One of the simplest outfits is a glass canning-jar or tumbler, with netting tied over the top. Another simple form is made by cutting a large hole in the cover and bottom of a shoe-box, and covering these holes with mosquito netting. A string is tied around the box to keep the cover on and the box set on edge; or a hole may be cut in the cover alone. This has the advantage of convenience in that the cover may be easily removed in order to feed the insects.

A chalk-box or cigar-box may be used and covered with a pane of glass. A very satisfactory combination is to fill a flower-pot with sand and to place on this a lantern globe with a piece of mosquito netting fastened on top, or a pane of glass placed across.

The cage must be kept clean, and the insects given fresh food every day. Sometimes moist dirt or a sod may be kept on the bottom of the cage. The grass in the sod will furnish food for some insects. When possible they should be given the same kind of food as that upon which they are found. If one does not know the food of the insect, grass and various kinds of leaves, such as cherry, may be tried. Clusters of leaves may be kept moist by placing the stems in a bottle

filled with moist sand, or with water if the mouth is filled so full that the insects cannot creep into the water.

A great variety of insects may be kept in these cages, such as grasshoppers, crickets, caterpillars, galls, and the various insects found in the garden. Water insects may be kept in a jar filled with water.

Insect nets. For collecting butterflies, dragon-flies, and other swiftly flying insects a net is necessary. One can easily be made by the children. Procure an old broom handle and a piece of stiff wire about four feet long. Bend this in the form of a circle about a foot in diameter, crossing the wires about six inches from the ends. Give them two firm twists. Bend each wire at right angles, about a half-inch from the twist, so that the two ends extend parallel about one inch apart. Place these two wires over one end of the broom handle and fasten one on each side of the handle by means of wire or heavy string.

Around the wire stitch a narrow border of sheeting, two or three inches wide. Make a net about thirty inches long out of cotton tulle or light cheesecloth. Sew this into a round bag at the bottom and attach the top to the border of the cloth on the wire. Mosquito netting may be used, but it is easily torn. The net should be at least twice as long as the diameter of the wire, so that when insects are caught in it, they may be imprisoned by a quick turn of the handle. One way to collect insects is to beat the top of grass back and forth with the net, when one will catch many insects that had not previously been seen.

Collections. The older children may make insect collections. For this purpose a cyanide bottle is needed for killing the insects, and some device for mounting them. The author believes that the best plan for school use is the one described in chapter IV of Hodge's *Nature-Study and Life*, to which the reader is referred.

Calendar. One way of stimulating the observation of the children is to keep an insect calendar in the spring. In its simplest form it may consist of the following columns: —

Name of insect	*Date first seen*	*Child first reporting*

If desired, other points may be added, such as place where seen, date when abundant, and kind of food.

Correlation (arithmetic). Insect study may be correlated with arithmetic, drawing, and literature. The following are given as suggesting the possibilities of insect problems: —

1. A mosquito lays about 200 eggs, and under favorable conditions these may develop into adult mosquitoes in 10 days. If one half of these eggs develop into females, each of which lays 200 eggs, how many mosquitoes would there be at the end of a month if all lived?
2. A young American silkworm of the polyphemus moth which had just hatched was weighed and found to weigh one twentieth of a grain; when 30 days old, 31 grains; when 56 days old, 207 grains. How many times its first weight was its weight at each of these days?
3. During these 56 days it consumed three fourths of a pound of leaves. How many times greater was this than its original weight? Than its weight when 56 days old?
4. An average locust weighs about 15 grains and is capable of consuming each day its own weight of standing crops, such as corn and wheat. Assuming that these crops are worth $10 a ton, and that there is 1 grasshopper to every square yard, how much damage do the grasshoppers do in a day on each acre? How much damage to the wheat and corn crop of Minnesota in which State about 7,000,000 acres are planted to these crops?
5. The United States Bureau of Entomology has made the following estimate of the per cent of damage done to crops by

insects. Work out the money loss in the last column for each crop and the total: —

Product	*Values*	*Percentage of loss*	*Amount of loss*
Cereals	$3,000,000,000	10	
Hay and forage	665,000,000	10	
Cotton	850,000,000	10	
Tobacco	100,000,000	10	
Truck crops	300,000,000	20	
Sugars	95,000,000	10	
Fruits	150,000,000	20	
Farm forests	110,000,000	10	
Miscellaneous crops	3,000,000,000	10	
Total			

6. Bring a grasshopper into the schoolroom. Measure the length of its body. Measure the distance and the height the grasshopper jumps. How many times its own length are these distances? If a boy could jump as far in proportion to his height as a grasshopper, how far and how high could he jump?

Correlation (art). Paper cuttings may be made of some of the larger insects. Colored drawings may be made of moths and butterflies, either with crayon or with water-colors. Or these may be cut free-hand first and then colored. When cocoons are kept in the room and the moths emerge, a good opportunity is afforded for this kind of work. Charts may be made of pictures and the children's own work in illustrating insect groups. The older children may make outline drawings of the insects studied, and paint the butterflies and moths in water-colors.

Grades and seasons. There is something of interest about insects for every grade, so that the study may extend all the way through the grades. The best time for most of the insect study is the autumn, because insect life is so abundant at that time. The study of the fly and mosquito may be taken up in the spring, because this is the best time to

take measures to control them. If collections of materials are made in the autumn, such studies as cocoons, galls, and wasp's nests may be taken up in the winter.

The following brief outline suggests the work adapted to the different grades and seasons. Detailed suggestions are found in the outline at the end of the book: —

Season	*Primary grades*	*Intermediate Grades*	*Grammar Grades*
Autumn	Grasshoppers	Insect activities	Pests of household
	Crickets	How they eat, breathe, and move	Enemies of garden
	Caterpillars	Social insects	Friends of garden
	Mosquitoes	Water insects	Insects and flowers
	Insect homes		
Spring	Butterflies		Fly and mosquito
	Moths		

Series of lessons on insects

A. For primary grades

TOPIC: GRASSHOPPERS (AUTUMN)

Materials: Keep grasshoppers in a breeding cage, as described in the first part of chapter, and feed every day with fresh grass. Let one grasshopper escape into the room, so as to watch it jump and fly. Have some of the children see how far and how high they can jump. Then compare with the distance the grasshopper jumps.

Child's problem.

We will watch these grasshoppers to see how they move.

Outline of development.

1. Jumping.
2. Crawling.
3. Flying.
4. Organs used:
   - A. How used.
   - B. Structure.
     - *a.* Difference between wings.
     - *b.* Difference between legs.

Application.

Ask children to watch grasshoppers out of doors, and notice which method of moving they see the grasshopper use the most.

Correlated work.

Literature.

Lovejoy, *Nature in Verse*, page 139.

Other lessons may be given on how the grasshopper cleans itself, eats, and breathes.

Topic: Galls (Autumn)

Materials: A collection of a number of common galls, such as can be found on the goldenrods, willows, and oaks. Cut a section through one of each kind.

Child's problem.

What kind of homes do the gall-dwellers live in?

Outline of development.

1. Plants on which found.
2. Parts of plants on which found.
3. Material of which made.
4. How made.
5. Differences in galls.
   - A. In shape.
   - B. In size.
   - C. In color.
   - D. In internal structure.

Application.

Ask the children to look for galls during the following week and see who can bring the most kinds to school. Have a school collection of galls made.

B. Lessons for intermediate grades

Topic: Insect Activities (Autumn)

Materials: Some water insects, such as the backswimmer, kept in a tumbler of water, a living grasshopper, butterfly, and beetle. The grasshopper possesses the biting mouth parts and

the method of using them may be shown by feeding it grass. The butterfly possesses the sucking mouth part, and its action may be shown by placing the butterfly on a bouquet of flowers. The motions of breathing may be seen in the abdomen of the grasshopper. The grasshopper illustrates three types of locomotion, jumping, crawling, and flying, using one pair of wings. The butterfly illustrates flying, using both pairs of wings. The backswimmer illustrates swimming. The beetle illustrates running.

Child's problem.

How do insects eat, breathe, and move?

Outline of development.

1. Eating.
   - A. Comparison of grasshopper and butterfly.
     - *a.* Kind of food.
     - *b.* Method of obtaining it.
     - *c.* Structure of mouth parts.
2. Breathing.
   - A. Motion of abdomen of grasshopper.
   - B. Number of breaths in a minute — compare with child.
   - C. Number and location of breathing pores.
3. Moving.
   - A. Jumping.
   - B. Crawling and running.
   - C. Swimming.
   - D. Flying (differences between grasshoppers and butterflies.)
   - E. Organs used.
     - *a.* Method of using them.
     - *b.* Structure.
     - *c.* Differences between wings of grasshopper and butterfly.
     - *d.* Differences between legs of grasshopper and of backswimmer.

Application.

Put the following tables on the board and have the children fill in with as many insects as they can, as the result of continued observation.

Methods of locomotion among insects

Flying	*Jumping*	*Running or walking*	*Swimming*

TOPIC: WATER INSECTS

Materials: Water strider, whirligig-beetle, glass dish. These and other water insects may be collected with an ordinary insect net, or with a handled strainer with wire on the bottom, such as is found in the kitchen. These insects may be kept several days without feeding. If desired to keep longer, feed with flies or raw meat. Perform the experiment of floating a needle on water.

Child's problem.

How do some insects live on the surface of the water?

Outline of development.

1. Method of floating.
   - A. Compare with needle.
   - B. Shadow of water strider.
2. Method of moving.
3. Breathing of whirligig-beetle below water.
4. Differences between the beetle and strider.

Application.

Have the children watch streams or ponds and report where they find these insects.

C. Lessons for grammar grades

TOPIC: THE MOSQUITO

Materials: Water stages of mosquito in glass tumblers covered with netting; kerosene, goldfish, tadpoles. The wigglers may first be studied to learn their habits. Then experiments in extermination may be tried. Place a counted number of wigglers in a jar with a fish. Note how long a time elapses before they are all eaten.

In another dish place some wigglers with a tadpole.

Try various kinds of water insects with the wigglers.

In another tumbler covered with netting and containing larvæ, pupæ, and adults pour a few drops of kerosene on the surface of the water and note results.

Child's problem.

What may be done to get rid of the mosquito?

Outline of development.

1. Life history of mosquito.
   - A. Larvæ.
     - *a.* Method of breathing.
     - *b.* Method of moving.
     - *c.* Position when at rest.
   - B. Pupæ.
     - *a.* Compare with larvæ in the three points given above.
   - C. Adult.
     - *a.* Note resting position.
     - *b.* Compare male and female.
     - *c.* Mouth parts.
2. Destruction and control of mosquito.
   - A. Natural enemies.
     - *a.* Fish.
     - *b.* Tadpoles.
     - *c.* Water insects.
     - *d.* Spiders.
   - B. Kerosene on water.
   - C. Destroy breeding-places.
   - D. Cover breeding-places.

Application.

Have the children search the neighborhood to find places where mosquitoes are breeding. Have a map made of the neighborhood to show the location of these breeding-places. Then have a campaign started by the children to prevent the mosquitoes from breeding, either (1) by putting oil on surface of pools; (2) by covering rain barrels; (3) by filling or draining pools; (4) by seeing that cans in dump heaps are turned bottom side up, or crushed.

Topic: The House-Fly (Spring)

In the late winter or early spring start a campaign of trapping the early flies. Send five cents in stamps for a fly-trap pattern to the International Harvester Company, Harvester Building, Chicago, Illinois. This gives detailed directions for making a fly-trap so that a child can do it. For fifty cents there may be obtained from the same company a set of about ten stencils, three feet square, of the house-fly, giving drawings that may be reproduced on the blackboard, on paper, or on cloth, which may be kept as permanent charts. Directions accompany these stencils showing the use that can be made of them.

Topic: The Lady Beetle

Materials: Secure the adult and larva of the lady beetle and keep it in a breeding-cage. The larva may be found on almost any plant infested with plant lice. Bring in a piece of plant with the lice and larva on it, and place the end in a bottle filled with moist sand. These lice are the food of both the larva and the adult beetle. When these are all eaten others should be brought in. In this connection the harm done by the lice may be studied.

Child's problem.

How is the lady beetle beneficial?

Outline of development.

1. The larvæ.
   - A. Appearance.
   - B. Method of feeding.
   - C. Comparison of pupæ with larvæ.
2. The adult.
   - A. Appearance.
   - B. Method of feeding.
   - C. Comparison with larvæ.
   - D. Method of flight.
   - E. Method of protection.
3. The lice.
   - A. Their appearance.
   - B. Method of feeding.
   - C. Harm done.

Application.

Have the children watch the house plants at home for these beetles to see what they are doing; also watch plants outdoors to find colonies of plant lice with the beetles and larva among them.

Correlated work.

Literature.

Ingpen, *One Thousand Poems for Children*, page 203.

Lovejoy, *Nature in Verse*, pages 168, 169.

Topic: Spiders (Autumn)

(Spiders are not insects, but they are closely related to them and will be taken up in this connection.)

Materials: If the class is taken for a field trip, webs for study may be easily found; or a web may be studied indoors. A web and spider may be found on a branch which may be brought into the schoolroom, and the branch stuck into earth in a flower-pot. Or a spider alone may be placed in a large breeding-cage with a few stems of plants to which it may attach its web. The spider may spin its web here.

Child's problem.

How is the web of an orb weaver made?

Outline of development.

1. Position of web.
2. Parts of web (radii, spiral and guy lines).
3. Two kinds of thread.
   - A. Difference in elasticity and adhesiveness.
   - B. Parts of web made of each kind.
4. Position of spider in web.
5. Method of catching insects. (Throw some insects, such as a fly, into the web.)

Application.

Ask the children to watch for spiders' webs and note the kinds of insects that they find in them, or note the different places where they find the webs.

Correlated work.

Art.

Have drawings made of the web, either on the board or on paper at the seats. Cuttings of webs may be made by the younger children.

Literature.

Lovejoy, *Nature in Verse*, pages 147, 222.

McMurry and Cook, *Songs of Tree-Top and Meadow*, page 158.

Ingpen, *One Thousand Poems for Children*, page 208.

Other lessons may be given on a funnel web and cobweb, and on a jumping, a running, and a flying spider, and on the nests in which the eggs are placed.

CHAPTER VIII

PETS AND DOMESTICATED ANIMALS (FOR PRIMARY GRADES)

The care of a pet is a splendid experience that every child should have. In caring for his pet he develops a sense of responsibility and the need of doing certain things at regular times. Through this care he comes to develop a friendly feeling for his pet and this gives him a more thoughtful feeling toward all animal life. And finally the child derives much pleasure from association with his pets through play and other means.

The studies made of pets may be carried on in two places; at home and in the schoolroom. Pets may be kept in a cage in the schoolroom where their habits may be studied, and points may be given for the children to observe in their pets at home. Such pets as the dog and the cat may be brought each day when needed, by the various children for a day only. Such pets as the rabbit and the squirrel may be kept in a cage in the schoolroom for several weeks. A cage may easily be made from a large box and some inch-mesh galvanized wire netting. This is better than mosquito netting. Some sawdust or dry dirt may be spread on the bottom of the cage. In order to avoid offensive odors, the animals should be fed on dry foods such as oats, corn, bread crust, nuts, and an occasional piece of some green stuff such as grass or lettuce. A pan of drinking-water should be kept in the cage. The cage should be kept clean. Another pet that can easily be kept in the schoolroom is the canary.

In connection with the study of the cat the children should

be taught how they can care for their cat so as to lessen as far as possible the harm it does in killing birds. Most of this harm is done to young birds in the spring and early summer, during the nesting season. Hence children should be taught to take special care of their cats during this season. The most harm is done during the early morning. During the nesting season of birds, cats should be shut up, especially at night and during the early morning; and at all times should be well fed, so that they will not have hunger added to their natural instinct as a stimulus to catch birds. The children should be taught that it is a cruel thing to the cat to abandon it when leaving their summer homes as so many people do.

Series of lessons on pets

In order to show the possibility of a series of lessons on one animal the three following lessons on the dog are given, based on an outline furnished the author by Miss Helen M. Reynolds, Principal of the Primary Department of the Training School at Mankato, Minnesota.

Topic: Kinds of Dogs

Materials: Pictures of dogs.

Child's problem.
How many different kinds of dogs are there?

Outline of development.
1. Pointers.
2. Hunters.
3. Hounds.
4. Spaniels.
5. Shepherd dogs.
6. Eskimo dogs.
7. St. Bernard dogs.
8. Differences in appearances.
9. Differences in uses.

Application.

Ask the children to look carefully at all the dogs they see and try to tell what kind each one is. Report to the class what they have seen. Make a list on the board of all the kinds that the children can find in town.

Correlated work.

Art.

Cuttings may be made of different kinds of dogs and of a dog in different positions; and a chart made to show the different kinds. Model in clay some of the different kinds of dogs.

Topic: Uses of Dogs

Child's problem.

In how many ways is a dog useful?

Outline of development.

1. To the grown-up people.
   - A. Hunting.
   - B. Herding sheep or cattle.
   - C. Protecting children.
   - D. Watching the house.
   - E. Performing labor.
     - *a.* Turning churn.
     - *b.* Drawing loads.
   - F. Find lost travelers in Alps.
   - G. Used as horses, Eskimo dogs.
   - H. As companions.
2. To the children.
   - A. As a playfellow.
     - *a.* Sports in which dogs join.
     - *b.* Tricks played by dogs.

Application.

Ask the children to notice all the helpful things they see dogs doing between now and the next lesson, and report to class.

Correlated work.

Literature.

Ingpen, *One Thousand Poems for Children*, pages 213, 214.

Topic: Care of Dogs

Materials: A dog may be kept in the schoolroom so as to watch its manner of eating.

Child's problem.

How may I take the best care of my dog so he will be healthy and happy?

Outline of development.

1. Food.
   - A. Kind of teeth.
   - B. Kinds of food needed.
   - C. Number of meals in a day.
2. Water.
3. Shelter.
4. Baths.
5. Protection from fleas.
6. Kindness.

Application.

Find out what care the children are giving their dogs, and if any are not giving the proper care, encourage them to do so, specifying what they should do.

Correlated work.

Art.

Have dog kennel made out of paper.

Topic: The Cat

Materials: A cat may be kept for a while in the schoolroom where its habits may be watched, and observations may be made by the children at home.

Child's problem.

To what extent can cats take care of themselves.

Outline of development.

1. Obtaining food.
   - A. Kinds of food.
   - B. How found — keenness of senses.
   - C. How caught.
     - *a.* Method of walking and springing.
     - *b.* Use of claws.

2. Protection.
   A. From enemies.
      a. Keen senses.
      b. Claws.
      c. Running away.
   B. From cold weather.
      a. Fur.
      b. Finding sheltered spot.
3. Cleanliness.

Application.

Ask the children to watch cats and see to what extent they are taking care of themselves without help from man.

Correlated work.

Art.

Children may make free-hand cuttings of cat or model one in clay.

Literature.

Ingpen, *One Thousand Poems for Children*, page 211.

McMurry and Cook, *Songs of Tree-Top and Meadow*, pages 52, 294.

Topic: The Cow

Materials: Samples of the products obtained from cows, such as cheese, butter, leather, gelatine, some milk which has been standing long enough for the cream to rise. It interests the children to make some butter in the schoolroom. To do this, put some sour cream into a quart Mason jar and screw on the top tightly. Pass it around and allow each child to shake it till the butter forms. Remove the lumps, wash in cold water, then mix it till the water is squeezed out. Add a little salt. Crackers may be provided and spread with butter and the children may have a little lunch.

Child's problem.

In what ways is the cow useful to us?

Outline of development.

1. Milk.
   A. Use uncooked.

a. Use of whole milk for drinking, cereals, etc.
b. Products from milk.
(1) Cream.
(2) Butter.
(3) Cheese.
(4) Uses of each.
B. Use of milk in cooking.
C. Forms in which kept for a long time.
a. Evaporated.
b. Condensed.
c. Dried.

2. Meat.
A. Steaks.
B. Roasts.
C. Stews.

3. Leather.
A. Shoes.
B. Harnesses.
C. Miscellaneous uses.

Application.

Ask the children to observe during a day the things they use, and notice how many of them come from the cow. In the grammar grades, especially in the country, the Babcock test may be demonstrated.

Correlated work.

Art.

Draw or make free-hand cuttings of cow, or model one in clay. Make a chart of a "Barnyard scene," or make it on a sand table.

Literature.

McMurry and Cook, *Songs of Tree-Top and Meadow*, page 86.
Wiggin and Smith, *Posy Ring*, page 114.

CHAPTER IX

LESSONS ON TREES

Motivation of tree-study. In many ways trees are the most satisfactory topics to take up in nature-study. They are common, large, beautiful, easy of access, always available all the year round, and they pass through an interesting series of changes from season to season. The children have many interesting experiences with trees which serve as a foundation for the work to be done. Trees furnish shade in the hot weather, the tree is the center of the Christmas festivities, in the autumn children play in the fallen leaves, they like to climb trees and build houses in their branches, and in the autumn they go nutting. The boys in manual training enjoy the use of tools with wood. All these activities furnish an abundance of experiences with which the school work can be linked.

Children delight in bright colors, and in the autumn work with the colored leaves appeals strongly to the young children. The desire to know the names of the trees is present. The collecting instinct may be appealed to throughout all the grades in collecting leaves or specimens of woods. Many games with leaves may be devised for the primary grades, as suggested on page 92.

The use of these lessons in the child's life may be suggested by encouraging him to find growing outdoors the trees studied, and to bring leaves to the class or to report where the tree was seen growing. A map may be made of a certain section near the school and all the trees growing there marked on it and named. The children may be asked to observe the shade trees to see if they are receiving proper

attention, with reference to pruning and protection. They may be encouraged to talk over the topic of the lesson with their parents and friends, and report what they learn. The older children may be asked to watch the newspapers and magazines for references to forest fires, and other items regarding trees and forests. These clippings may be cut out and brought to school and posted in an area reserved for this purpose.

Materials. A great abundance of material may easily be obtained. In the autumn, when the leaves begin to fall, they may be secured in sufficient quantities to supply each pupil with material. At this same season many fruits of trees, such as acorns and nuts, can be obtained. During and just after the Christmas season branches of various kinds of evergreens may be secured. During the winter twigs of trees may be brought into the schoolroom. In the early spring twigs may be brought indoors and forced to develop earlier by placing in water. It is well to cut off about a half-inch from the lower end of the twigs every week or two. The best twigs to select for this purpose are those that open quickly and have large parts, such as the horse-chestnut, lilac, pussy-willow, and fruit trees. In the spring flowers of trees may be secured. Those which have conspicuous flowers, such as fruit trees, locusts, horse-chestnut, and catalpa, are better adapted for this purpose for the primary grades. For the older children the less conspicuous flowers of other trees may be obtained. The fruits of the elms and white and red maples may be obtained during the spring term.

Collections. Children are interested in making collections. One may be made showing how trees scatter seeds. In the grammar grades collections can be made of the different kinds of woods used in carpentry, and of small limbs of trees from one to two inches in diameter. These specimens may be neatly cut up into uniform sizes, and the

cut surfaces polished to show the structure. Cuts may be made to show cross, tangential, and radial sections. These specimens may be kept loose or mounted in a frame.

Collections of leaves. Collections of leaves are easily made, and the gathering and labeling of the specimens lead to identification of the trees. These collections may be made in three ways: first, by pressing and mounting the leaves; second, by waxing and ironing the leaves; third, by making blue prints. The fall is the best time to make these collections, as the leaves may be gathered when they begin to show their autumn colors.

Pressing leaves. In order to press the leaves secure two pieces of board about a foot long and eight or nine inches wide, old newspapers, and a heavy weight, such as a stone. The leaves are placed between the folds of a newspaper, several leaves to one piece. These papers are put one on top of the other with extra folds of paper between, so as to absorb the moisture. This pile of papers is arranged on one of the boards, the other board is set on top, and on this is placed a stone. This is allowed to stand for a week or two. For a still simpler method the leaves may be laid between the leaves of an old book and a weight set on the book. The leaves may be mounted on unruled notebook paper by means of glue or gummed paper.

An interesting project for the older children is to collect the leaves of all the deciduous trees in the locality and make an exhibit, to which the friends and parents of the children are invited. The children may be divided into groups, and each group assigned a certain family of trees to collect; such as the maples, the elms, the oaks, the birches, the willows, the poplars, the ashes, the nut trees, the locusts, and a few trees will be left which may be placed in a miscellaneous group. These leaves may be pressed and mounted as explained above. The fruits may also be collected. The chil-

dren may be asked to look up interesting facts about the group of trees they are collecting, so that they may be able to answer questions and give explanations at the exhibit.

Waxing leaves. The autumn colors are best preserved by waxing the leaves. Scatter over the leaf small bits of wax or paraffin, then pass over these a moderately hot iron. Treat the other side in the same way. The leaves may also be dipped in melted paraffin. Still better is to cover them lightly with melted paraffin, using a small soft brush. The leaves may then be mounted on paper with glue.

Blue prints. A collection of blue prints of leaves is very attractive. These prints are easily made and show not only the outline, but sometimes the veining, of the leaf. A blue print is put on a piece of cardboard, the leaf is arranged on this, and a piece of glass placed over all. These are held in position by clips or by the hand and exposed to the bright sun till the paper turns to a bronze shade. This is then washed in running water or several changes of water and then dried.

Calendars. Calendars are a means of arousing the children's interest and of stimulating their observations of trees. A large piece of cardboard may be used for these calendars. Each one should have some artistic decoration suggestive of the topic to be recorded. These may be kept in both the spring and fall. In the spring two kinds may be kept as the buds open, one of the first appearance of the leaves, and another of the first appearance of the flowers. These may be kept in a form like the following: —

Flower calendar of trees

Name of tree	*Date first flower seen*	*Location of tree*	*Name of child first reporting*

Leaf calendar of trees

Name of tree	*Date first leaf seen*	*Location of tree*	*Name of child first reporting*

In the autumn two calendars may be kept, one of the coloring of the leaves, and one of their fall: —

Calendar of leaf-coloring

Name of tree	*Date first colors seen*	*Colors seen*	*Location of tree*	*Name of child first reporting*

Calendar of leaf-fall

Name of tree	*Date first leaves fall*	*Date when all leaves have fallen*	*Location of tree*	*Name of child first reporting*

In keeping the last two calendars the children should be expected to bring the leaves to school before the record is put on the calendar.

Games. The use of the game element will interest the children and may be used as a means to help them identify the leaves. The same sort of games may be played with

leaves as with bird pictures, a list of which is given on page 53.

Arbor Day. In those States where Arbor Day is observed, some special program should be arranged. The central idea should be the planting of some tree, shrub, or vine; and the children should be encouraged to plant something at home. The formal exercises may consist of a talk by the teacher or by some one outside of the school, reports of the children on their observations of trees, original essays by the older children, recitations of poems and prose selections about trees, and appropriate songs.

Correlation. Tree-study lends itself admirably to correlation with other subjects, especially art and literature. In the autumn much interesting work can be done with colored leaves. The younger children can make free-hand cuttings and then color them with crayons. The older children may make drawings of leaves or paint them with water-colors. Cuttings may be made showing the shape of whole trees. Charts may be made showing how trees are cut, how the wood gets to us, and the uses made of wood. Blue prints may be made of leaves and of the opening buds. The work that the children have done for a year showing the trees at different seasons may be bound together to form booklets. Shapes of trees, nuts, and fruits may be modeled in clay by the primary children.

Grades and seasons. There is something of interest about trees for every grade. In the primary grades studies may be made of the colored leaves in the autumn and the children may be taught to identify a few common trees from their leaves, including a few Christmas trees. In the intermediate grades the children may be taught to recognize a larger number of the common trees, and some study of their uses may be made. In the grammar grades special attention may be given to the uses of trees and to the subject of forestry.

Every season has something of interest. In the autumn the leaves and fruit may be studied and the coloring and fall of the leaf. In the winter evergreens and the bark, branching, shape, and twigs of the deciduous trees may be studied. In the spring the opening of the buds and the flowers found at this time may be noted. The topic of forestry may be taken up during any portion of the year.

The following table suggests in a concise form the distribution of the topics according to grade and season: —

Season	*Primary Grades*	*Intermediate Grades*	*Grammar Grades*
Autumn	Colored leaves Identification of a few common trees Nuts	Study of groups of trees, as shade, fruit, and nut trees Tree fruits Calendars	Forest trees Forest fires
Winter	Christmas trees	Evergreens Winter characters — shape, barks, buds of deciduous trees	Value of forests Enemies of forests Identification of deciduous trees
Spring	Opening buds of trees studied in fall Flowers of fruit trees	Opening buds of trees studied in fall Flowers of trees Calendars	Conservation of forests

Series of lessons. A few lessons on trees are suggested below in brief outline form. In the study of particular kinds of trees one species should be followed through the whole year, so as to notice the changes through which it passes: the foliage in the early autumn; the leaf-coloring and fall in the late autumn; the shape, branching, and bark in the winter; and the opening buds in the spring.

A. Lessons for primary grades

Autumn Leaves (first grade)

The first study of trees may well be made with the colored leaves. A pile of leaves should be provided illustrating as great a variety of colors as possible.

Have the children group the leaves according to color into separate piles — one for red, one for yellow, one for brown, and one for green.

The leaves may be grouped again according to the combinations of colors; those in one pile that have both red and yellow; in another pile those that have both yellow and brown and so on.

The leaves may be grouped according to shape; those of similar shape being put in one pile; they may be grouped again according to size.

The children may cut leaves free-hand from paper and then color them with crayons, or the coloring may be done without cutting. Some of the prettiest leaves may be waxed, as explained in a previous part of the chapter.

Some of the following poems may be read to the children: —

Lovejoy, *Nature in Verse*, pages 29, 203–206, 208.

McMurry and Cook, *Songs of Tree-Top and Meadow*, page 16.

Topic: Christmas Trees

Materials: Twigs of several kinds of evergreens.

Child's problem.

How can we tell the different kinds of Christmas trees apart.

Outline of development.

1. Shape of leaves.
2. Size of leaves.
3. Arrangement of leaves.
4. Kind of fruit.

Application.

Ask the children to bring to school twigs of Christmas trees and name them.

Correlated work.

Art.

Have free-hand cuttings made showing the shapes of Christmas trees. Drawings with colored crayons may also be made.

Literature.
Lovejoy, *Nature in Verse*, page 285.
Lovejoy, *Poetry of the Seasons*, page 295.
Wiggin and Smith, *Posy Ring*, page 265.

B. Lessons for intermediate grades

Topic: The Maples

Materials: Leaves of maples growing in the vicinity, including the box-elder.

Child's problem.
How can we tell the members of the maple family apart?

Outline of development.
1. Differences in shape of leaves.
2. Differences in margin of leaves.
3. Differences in kind of leaves (simple or compound).
4. Differences in color of under side of leaves.
5. Differences in autumn colors.
6. Differences in bark.
7. Differences in fruit.

Application.
Ask the children to look for each of these kinds of maples and bring a leaf of each to school, or report where they saw the trees growing. Have them watch the autumn coloring for any differences.

Correlated work.
Art.
Have the children make outline drawings of leaves or blue prints.
Literature.
Wiggin and Smith, *Golden Numbers*, page 17.
Stone and Pickett, *Trees in Prose and Poetry*, pages 32–41.

Topic: Uses of Wood

Materials: Samples of the more commonly used woods.

Child's problem.
What are the most important uses made of wood?

Outline of development.

1. For building.
2. For furniture.
3. For musical instruments.
4. Miscellaneous uses.

Application.

Ask the children to note especially for a few days the uses they see made of wood and report any new uses, and find out what kinds of wood are used most commonly. Have a collection made of the different kinds of wood.

Correlated work.

Literature.

McMurry and Cook, *Songs of Tree-Top and Meadow*, page 29.

C. Lessons for grammar grades

Topic: Forest Fires

Materials: Pictures showing effects of fires and men fighting fires.

Child's problem.

How may forest fires be controlled?

Outline of development.

1. Causes of fires.
2. Damage done.
3. Kinds of fires.
4. Preventing fires.
5. Putting out fires.

Application.

Ask the children to watch the papers for reference to fires and to cut out the clippings and bring to school.

Topic: Work of National Government to protect Forests

Materials: Map showing location of national forests; pictures of rangers at work in forest; samples of bulletins published by the Forest Service.

Child's problem.

What is our National Government doing to protect our forests?

Outline of development.

1. National forests.
    A. Location.
    B. Number and uses.
    C. Care and use.
2. Forest Service.
    A. Work at Washington.
    B. Work in the forests.

Application.

Ask the children to watch the papers and magazines for reference to the national forests or the Forest Service, and to bring clippings to school.

CHAPTER X

LESSONS WITH FLOWERS

The study of flowers. There is something about flowers that appeals to every one, both young and old. The young child is interested in the bright colors and wishes to know the names of the flowers. In the primary grades the chief thing to emphasize is identification. After a flower is studied in the schoolroom the children should be encouraged to find the flower growing in its natural environment. Care should be taken to see that flowers are not picked needlessly, especially the rare ones, some of which are in danger of extermination in the neighborhood of cities.

There is one set of flowers to be studied in the spring and another set for autumn. Something of interest may be found for study in every grade. The purpose of the study of flowers should be to acquaint the children with the more common forms of wild flowers, so that they may know and appreciate them, and thus want to preserve them. The older children may be taught something about the economic side of pollination.

Materials. A freshly picked bouquet of the flowers to be studied can usually be obtained, so that there will be plenty of material for schoolroom use. During the spring a single plant of the various flowers studied may be dug up with some soil and put in a flower-pot. This may be kept in the schoolroom and watered. In this way the whole development of the plant may be followed from the opening bud to the fruit. While the children are interested chiefly in the flowers of plants, attention should also be called to the leaves and fruit of the various plants studied.

Calendar. The flower calendar is always a means of arousing interest and of stimulating outdoor observation on the part of the children. A large piece of cardboard should be secured, and at the edge or top should be placed some artistic decoration suggestive of flowers. The cardboard should then be ruled off into columns for keeping the records of the flowers brought in. The following outline is suggested: —

Flower calendar

Name of flower	*Date brought in*	*Name of child first bringing it*	*Place where found*

Another way of keeping a calendar is to press and mount the flowers as they are brought in, as explained on page 90, for the leaves of trees. On each card put the four facts called for in the headings given above. These cards may be hung on the walls of the room. Both kinds of calendars may be kept in either spring or fall.

Games. The bird games suggested on page 53 may be easily adapted to flower games. For these games a bouquet of a number of different kinds of flowers will be needed. Another game called "the florist" may be played. Bouquets of both wild and cultivated flowers are placed on the desk. One child sits at the desk and supposes that he is a florist with flowers for sale. The other children in turn come to the desk and ask for a certain flower. If the florist gives the wrong flower, some other child takes his place.

Wild-flower garden. If there is a shady corner of the yard that is not used, it may be spaded up and made into a wild-flower garden. During the spring the roots of various kinds of wild flowers may be dug up and transplanted

into this garden. In a few years a collection of the more common flowers may thus be secured in the school yard.

Correlation. Flower-study lends itself splendidly to correlation with art. In connection with the science lessons, following the study of a flower, the children may draw the flowers with colored crayons or paint them with water-colors. The best drawing of each flower may be selected and put on the wall, and thus a collection may be made of the best drawings.

Blue prints may be made of some of the flowers. These will show the outline of the leaves and something of the shape and grouping of the flowers. A flower garden may be made in the sand table.

There is a large amount of good literature on flowers, and some of the best of these selections may be read in connection with the study of the flowers. Flower-study may also be correlated with language lessons. Topics about which the children are to talk or write may be selected from their observation of flowers.

Series of lessons on flowers

A. Lessons for primary grades

General Study of Flowers (Autumn)

Secure a bouquet containing a great variety of flowers. Have the children sort the flowers by colors into separate piles, each color by itself. When more than one color is found on a flower, use the most prominent one for sorting.

Again have the children sort the flowers into two piles, one containing the large flowers and the other the small flowers, first selecting some flower for a standard size.

Sort the flowers into two piles, those that the children know and those that they do not know. The names of the unknown flowers may be written on slips of paper, and a slip given to each child who is asked to pick out this flower.

Sort the flowers into two piles, those having a distinct odor and those having little or no odor.

TOPIC: GOLDENROD (AUTUMN)

Materials: Bouquet of goldenrods, enough so each child can have a spray.

Child's problem.

How can we tell the goldenrod from other fall flowers when we see it growing?

Outline of development.

1. Color.
2. Size of flowers.
3. Grouping of flowers.
4. Arrangement on stem.
5. Place of growth.
6. Height of plant.

Application.

Ask each child to find a goldenrod growing, and to bring one to school the next day to make a bouquet for the schoolroom.

Correlated work.

Art.

Have the children draw pictures of the goldenrod, using colored crayons.

Literature.

Lovejoy, *Nature in Verse*, page 193.

B. Lessons for intermediate grades

TABLES FOR REVIEW

Toward the end of the spring and again in the fall, about the time that the last flowers appear, the children's knowledge of flowers may be briefly reviewed by using the following tables. These may be put on the board and the names of the flowers that the children know put in the proper columns.

Flowers grouped according to color

Red	*Yellow*	*Blue*	*Pink*	*White*

Flowers grouped according to habitat

Flowers growing

In woods	*In fields*	*In pastures*	*In swamps*	*By roadside*

TOPIC: POLLINATION OF APPLE BLOSSOMS (SPRING)

Materials: Enough apple blossoms to supply each child with a specimen.

Child's problem.

In what ways is the apple blossom adapted to bring about insect pollination?

Outline of development.

1. Reason for insects' visits.
   - A. Nectar.
   - B. Pollen.
2. Means of attracting attention of insects.
   - A. Colors.
   - B. Odors.
3. Value to flower of visits.

Application.

Ask the children to watch an apple tree and see what insects they find visiting the flowers.

Correlated work.

Art.

Have drawings made with crayons or water-colors.

Literature.

Lovejoy, *Poetry of the Seasons*, page 75.

Wiggin and Smith, *Golden Numbers*, page 63.

Topic: Vines (Autumn)

Materials: Obtain illustrations of as many of the following types as possible: twining stems (bittersweet, morning-glory, moonseed), twisting petioles (nasturtiums, clematis), tendrils (sweet pea, grape), suckers (woodbine).

Child's problem.

What are the different ways in which vines climb?

Outline of development.

1. By twining stems.
2. By twisting petioles.
3. By tendrils.
4. By suckers.
5. Support required by each of the above.

Application.

Ask the children to observe a number of vines before the next lesson, and notice the method by which each climbs. Report to class. From these reports determine which is the most common method.

Have a collection made of the leaves and climbing portions of the vines. These should be pressed and mounted on a large cardboard.

Correlated work.

Art.

Have drawings made of each of the above types.

Literature.

McMurry and Cook, *Songs of Tree-Top and Meadow*, page 72.

Lovejoy, *Poetry of the Seasons*, pages 323, 324.

CHAPTER XI

SEED-DISPERSAL AND FLOWERLESS PLANTS

1. Seed-dispersal

SEED-DISPERSAL is a topic that always appeals to children. Nearly every child has blown on a head of dandelion seeds to see if his mother wants him. The material is abundant in the autumn, and easy to secure.

One of the most interesting lines of work is to have collections made of the various seeds. These may be mounted in several ways. One way is to secure from the drug-store a number of small vials with stoppers, and place one kind of seed in each bottle. These bottles may be mounted on a cardboard by means of a piece of elastic, and the names may be written on the cardboard beneath the bottle, or a label may be pasted on the bottle; or the seeds may be fastened directly onto the cardboard by means of glue or mucilage. These collections may be class affairs, all the children helping to furnish seeds for the collections.

For the younger children the following topics for collections are suggested: Seeds that fly. Seeds that steal a ride. Seeds scattered by birds. Seeds scattered by the plant itself.

For the upper grades two central topics may be taken for the collections: dispersal of tree seeds and of weed seeds.

Series of lessons for primary grades

TOPIC: SEEDS THAT FLY (AUTUMN)

Materials: Seeds to illustrate the four types of distribution mentioned below; such as milkweed, dandelion, aster, maple, ash, box-elder, tumbleweed, bladder nut, hop. Allow the children to blow some seeds to see how they float and how far they travel.

Child's problem.

How are some seeds made so that they can fly?

Outline of development.

1. Seeds with hairs.
2. Seeds with wings.
3. Comparison of two types.
   - A. Method of flying.
   - B. Distance carried.
4. Tumbleweeds.
5. Inflated pods.

Application.

Have the children make a collection of seeds that fly. One third might collect seeds with hairs, another third seeds with wings, and another third inflated pods.

Correlated work.

Literature.

Lovejoy, *Nature in Verse*, page 15.

A special lesson may be given on one plant alone, such as the dandelion or milkweed, making a study of the whole plant, including stem, leaves, fruit, and flower.

Topic: Seeds that steal a Ride

Materials: A variety of seeds distributed by animals; such as burdock, clotbur, pitchforks, tick-trefoil.

Child's problem.

How are some seeds made so that they can steal a ride?

Outline of development.

1. Adaptation for sticking.
   - A. Burdock.
   - B. Pitchforks.
   - C. Tick-trefoil.
2. How carried.
   - A. By animals.
   - B. By man.

Application.

Have the children make a collection of "Seeds that steal a Ride," trying to see how many kinds they can find.

Correlated work.

The children may use the burdock burs to make various objects; such as baskets, chairs, tables, houses, etc.

Literature.

Lovejoy, *Nature in Verse*, page 122.

A separate lesson may be given on the burdock alone, making a study of the whole plant.

2. Flowerless plants

Mushrooms. Mushrooms have a number of characters that make them interesting objects for study; some of them are edible, some are brightly colored, there are many different kinds, and they are of wide distribution. They are of further interest on account of their method of getting food. They cannot make their own food, but get it from other plants or animals, either living or dead.

Their food value has been exaggerated. Their chief value is as a food accessory. There is no easy and infallible way by which one may separate the edible from the poisonous species. The only safe way is to collect only those species which are known to be edible and leave the unknown alone, if one is collecting for eating. There is no danger in handling the poisonous species. Certain kinds of mushrooms, such as the coral mushrooms, are all edible, and so may be collected and eaten without danger.

Lesson on mushrooms (intermediate grades)

Materials: Several days before the lesson is to be given, the children should be asked to collect all the mushrooms they can and bring them to school. Most of the common kinds can be put into one of the groups given below. Have spore prints made of several species. Cut off the stems near the cap, and place the cap gills down on a piece of paper. Cover the whole with a dish and allow to stand overnight. The spores will fall down and form a spore print on the paper. If it is desired to make permanent prints, spread a thin coating of mucilage over the paper, and support the cap on each side with matches so that the gills do not touch

the mucilage. When the mucilage becomes dry, the print may be stored away and kept.

Child's problem.
How do mushrooms differ from each other?

Outline of development.
1. Gill-bearing mushrooms.
2. Pore-bearing mushrooms.
3. Spine-bearing mushrooms.
4. Puffballs.
5. Coral mushrooms.
6. Cup fungi.
7. Characters of each of the above groups.

Application.
Ask the children to look for the different kinds of mushrooms and report of which kind they see the most during the following week. Have a collection of spore prints made on mucilaged paper.

Correlated work.
Art.
Have drawings made of some of these forms either with pencil or water-colors.

Ferns. Ferns are attractive on account of the beauty of their foliage. They may be grown as house plants or set outdoors in some shady place. An appropriate place in the school yard may be selected and specimens of the different kinds of ferns found growing in the neighborhood may be dug up in the spring and transplanted here. These will add to the beauty of the yard and also furnish materials for science lessons.

Study of ferns (intermediate grades)

Materials: Fronds of at least two species of ferns. The house fern may be used for one.

Child's problem.
What are the differences in ferns by means of which they may be told apart?

Outline of development.

1. Leaves.
   - A. Size.
   - B. Number of times divided.
   - C. Edges.
2. Fruit dots.
   - A. Position.
   - B. Arrangement.
   - C. Shape.

Application.

Have the children make a collection of as many kinds of ferns as they can find. These may be pressed and mounted like leaves, as explained in the chapter on trees, or blue prints of small portions of the frond may be made. A series of paintings, mounted specimens, and blue prints for each species would make an interesting and valuable collection.

Correlated work.

Art.

Have drawings or paintings made of the various species.

Literature.

McMurry and Cook, *Songs of Tree-Top and Meadow*, page 15.

PART III
AGRICULTURAL SCIENCE

CHAPTER XII

GARDENING

The home-garden movement. In recent years there has developed in this country a great movement to encourage home gardening by children. In some cities the movement has been carried on by civic organizations. In other cities it has been under the supervision of the schools. This latter method seems the better and final solution of the problem, because if it is done as a part of the school work it will become permanently established. In order that the garden work should be carried on most effectively, there should be some one employed to visit the home gardens during the summer and give such help as may be needed. The National Bureau of Education is advocating that school boards employ one teacher for twelve months, who shall have supervision of the home gardens during the summer and teach some of the regular school subjects during the rest of the year. In some towns the instructor in agriculture in the high school supervises the children's gardens during the summer.

Frequently prizes are offered for the best gardens, or pupils are given school credit for the work done in the home gardens. But even without a special supervisor much can be done on the part of the regular teachers who can seek to interest the children and teach the steps necessary to start their garden. And if a supervisor is provided, the help of the teachers is needed to coöperate with her.

One effective way of getting the children to start a garden is to give them a means of buying penny packets of seeds.

A number of firms are now selling seeds at this rate to school children.

Children's interests in kinds of gardens. Young children are more interested in the flower and vegetable gardens than in the fruit garden, because the latter requires such a long time before any returns are secured, excepting the fall strawberry. The relative interest in the flower garden and vegetable garden depends on the age and sex of the children. In general, girls are more interested in the flower garden, and boys in the vegetable garden; and the younger boys are more interested in the flower garden than are the older boys. The financial side of the vegetable garden appeals quite strongly, however, to all children. In many portions of the country girls' clubs are being formed for the raising and canning of vegetables.

Value of gardening. Every child should have some experience in gardening. It teaches children many valuable lessons. Dr. Hodge has well said: "The vandalism, juvenile and even adult, that renders pursuit of horticulture in a New England city or town well-nigh impossible, must be accounted a first fruit of this universal neglect" of the study of gardening in the schools.

A large amount of pleasurable and profitable work in growing plants is possible in the home grounds. Even in the small city lot, with only its back yard available, a great deal can be done; while, as the size of the yard increases, the possibilities increase accordingly.

Æsthetic value. One of the chief values of gardening is the æsthetic value. One derives a great deal of pleasure in raising plants and watching them grow. It is a source of never-ending pleasure to start each spring with the seeds and watch the wonderful changes that occur till the mature plant is formed. The foliage of some garden plants is attractive. In the case of the flower garden there is an added

pleasure on account of the beauty of the flowers that one can raise. Garden work leads to the cleaning-up of the back yards, thus adding to the beauty of the home grounds.

Economic value. The home garden has a very important place for its value in reducing the cost of living. The unprecedented rise in the cost of foodstuffs during the last few years presents a serious problem to the great majority of people. This financial stress may be greatly relieved by raising vegetables in the home garden. Even a small garden will furnish enough vegetables for a family during the summer, and a medium-sized garden will furnish in addition enough to can or store in the cellar for winter use; while as the garden becomes larger, some of the produce may be sold. This possibility of earning money is a motive that appeals strongly to children.

A child with a garden including twenty-five hundred square feet should be able to raise at least ten dollars' worth of produce. In larger gardens some city children have made from one hundred to three hundred dollars. With proper direction a large number of children should be able to earn one hundred dollars. When we think of the army of over twenty million school children in this country, most of whom are free from school duties during the summer, we see the tremendous possibilities. If one half of these should have a garden, and each raise only ten dollars' worth of produce, that would mean a total of one hundred million dollars, or an average of one dollar to every man, woman, and child in the United States. Surely this would be worth while from the economic standpoint alone, without reference to the many other values of gardening.

Hygienic value. Another value of gardening is found in its effect on health. This is produced in two ways. First, there is the value of exercise in the open air. Exercise is one of the essentials in maintaining health, and gardening fur-

nishes a valuable kind. A second effect on health is produced because the garden furnishes a healthful kind of food and it may be obtained fresh, which makes it more healthful than the vegetables that one buys at the store, which have been standing some time. Many people eat too much meat food and their health is injured thereby. Anything which encourages eating less meat and more vegetables and fruits, as a home garden does, makes for better health. And when one cans his own fruits and vegetables he may be sure that they are clean.

Ethical value. And finally, and perhaps of more importance than anything else, are the lessons that the child learns which affect his character. The care of the garden develops in the child a sense of responsibility and respect for the property rights of other people through his feeling of ownership for his own garden. And through his own labor he develops an appreciation of the dignity of labor.

It is a great misfortune that so many children have nothing to occupy their attention during the long summer vacation. As a result they acquire habits of idleness; or even worse, in their efforts to find something to do, many acquire habits which are positively harmful. Gardening furnishes the children something definite to take their attention and to occupy their time in a profitable way, allowing them to earn money as a result of their labors. In marketing the products they also acquire a desirable business experience. Thus the child acquires habits of thrift instead of habits of idleness.

Another advantage of the home garden is that it connects the school life of the child with his home life, and brings the teacher and parents together and produces a better understanding between them.

Motivation in gardening. There are three main motives to which appeal may be made to induce the child to start a

garden: the desire to earn money, the desire to eat products of his own raising, and the pleasure that the child derives from the various garden activities. The desire to earn money is a strong motive. The produce can be sold, either at home or to neighbors who have no garden, or to the stores. In some towns prizes are offered for the best gardens, and the game element of competition enters to furnish an additional stimulus. And even if no produce is sold, there is the appeal that comes from having the products of his labor for his own use. The children are interested also in the manual activity involved and in the fact that it is done out of doors. The rapid changes that take place in the plant as the seed germinates and the plant grows hold the child's interest.

The work in gardening as it may be carried on in the schoolroom may be divided into four groups, as follows: —

I. A study of the products of gardening.
   A. Cultivated flowers.
   B. Vegetables.
   C. Fruits.
II. Lessons to encourage home gardening.
   A. Reasons why the children like to have a garden.
   B. Give means of securing penny packets of seeds.
   C. Making plans of home gardens.
   D. How to prepare the soil.
   E. How to plant seeds.
   F. How to transplant seedlings.
   G. How to thin seedlings.
   H. How to care for the gardens.
III. Growing house plants in the schoolroom.
   A. Flowers from bulbs.
   B. Growing other house plants.
   C. Propagation of house plants.
IV. Experiments with plants.
   A. Raising plants in schoolroom from seeds.
      1. To obtain the final product.

2. To raise seedlings to transplant in the home gardens.
3. To watch changes in seeds and seedlings.
4. To make an eggshell garden.

B. Germination experiments.
1. Conditions for germination.
2. Depths of planting.
3. Testing vitality.
4. How a squash seedling gets out of the seed coat.
5. What happens to the cotyledons.
6. How seedlings break the soil.
7. Use of cotyledons to seedlings.
8. To show the expansive power of germination of seeds.

C. Work of roots.
1. Absorption of water.
2. Root hairs.
3. Direction of growth.
4. Food storage — carrot basket.

D. Work of stem.
1. Passage of liquid up.
2. Passage of liquid down.
3. Direction of growth.

E. Work of leaf.
1. Transpiration.
2. Light and starch-making.
3. Leaf exposure to sunlight.
4. Sleep movements of leaves.
5. Effect of light on growth of stem and leaves.

1. Study of products of the garden

Most of this work can best be carried on during the autumn and winter, excepting for a few plants that mature during the spring term, such as strawberries. The purpose of this study is to arouse more interest in garden products through a better understanding of their value and of how they have been raised, and thus to create an interest in the children to have a garden of their own.

Lesson on products of the garden

A. For primary grades

Topic: The Nasturtium (Autumn)

Materials: Nasturtium flower and leaf for each child.

Child's problem.

How can we tell the nasturtium from other flowers the next time we see it?

Outline of development.

1. Color of flowers.
2. Shape of flowers.
3. Size of flowers.
4. Shape of leaf.
5. Height of plant.
6. Place where plant grows.

Application.

Ask each child to bring a nasturtium to school to make a bouquet for the room, or to notice all the places where they see nasturtiums growing and report to the class.

Correlated work.

Art.

Have the children draw the flower, using colored crayons. Blue prints of the leaves may be made.

Topic: The Tomato

Materials: Ripe and green tomatoes, flowers, piece of plant.

Child's problem.

What things have been done so that we might have these tomatoes?

Outline of development.

1. Saving seeds.
2. Starting seeds indoors.
3. Transplanting.
4. Hoeing.
5. Making support for the plant.
6. Harvesting.
7. Stages of development.

Application.

Ask the children to watch people who have tomatoes in their gardens and see what they are doing to them at this time of the year, and later when the first frost comes.

Correlated work.

Art.

Have the children model a tomato in clay, or draw both green and ripe tomatoes with colored crayons. Cut sections across tomato and have the children draw.

B. Lessons for intermediate grades

Topic: The Marigold and Cosmos

Materials: Flowers and leaves of the marigold and cosmos.

Child's problem.

Which flower would you prefer to have in your garden, the marigold or the cosmos?

Outline of development.

1. Comparison of colors.
2. Comparison of foliage.
3. Length of time in bloom.
4. Height of plants.
5. Effect of first frosts.

Application.

Ask the children to look and see which flower is more commonly grown in their neighborhood, also to notice after the first frost if there is any difference in the effect on these flowers.

Correlated work.

Art.

Have paintings made of flowers and leaves in water-colors.

Literature.

Lovejoy, *Nature in Verse*, pages 130, 198.

Topic: Corn (Autumn)

Materials: An entire corn plant dug up, including the roots, silk, and tassel, and ears of corn in different stages of development.

Child's problem.

What are the parts of a corn plant that help to grow the ears of sweet corn?

Outline of development.

1. Roots.
   - A. Ordinary soil roots.
   - B. Prop roots.
   - C. Work of the root.
2. Stem.
   - A. Nodes and internodes.
   - B. Appearance of cross-section.
   - C. Work of the stem.
3. Leaves.
   - A. Length.
   - B. Edges.
   - C. Sheath.
   - D. Rain guard.
   - E. Work of leaf.
4. Flowers.
   - A. Tassel
   - B. Silk.
   - C. Compare with ordinary flower like nasturtium.
   - D. Work of flower.
5. Ears.
   - A. Relation to tassel and silk.
   - B. Number to a plant.
   - C. Position on stem.

Application.

Ask the children to observe other corn plants growing and to notice how they differ from the plants studied.

Correlated work.

Art.

Have drawings made of the whole plant; also of cross-section of stems.

Literature.

Ingpen, *One Thousand Poems for Children*, pages 164–65.
Lovejoy, *Nature in Verse*, pages 227–28.
Lovejoy, *Poetry of the Seasons*, pages 233–37.
Wiggin and Smith, *Golden Numbers*, pages 82, 84.
Wiggin and Smith, *Posy Ring*, pages 93, 248.

C. Lessons for grammar grades

Topic: Storing Vegetables (Autumn)

Materials: One sample from each of the groups outlined below.

Child's problem.

In what ways may vegetables be stored for winter use?

Outline of development.

1. Temporary storing of tomatoes after frosts.
2. Storing in cellar at medium low temperature (squash, pumpkin).
3. Storing in cellar at low temperatures (but not freezing) potatoes, beets, carrots, turnips (the last three in moist sand).
4. Allowing to stay outdoors and freeze (parsnips, oyster plant).

Application.

Suggest that those who have gardens at home find suitable conditions for storing their vegetables, so that they can have them next winter. Those who do not have gardens may watch other people to see how they store their vegetables.

Topic: Canning Fruits (Spring)

Materials: Pictures showing canning outfits.

Child's problem.

How may fruits be canned?

Outline of development.

1. Kinds of fruit best adapted for canning.
2. Principles involved.
   - A. Killing bacteria.
   - B. Preventing other bacteria from entering.
3. Outfit needed.
4. Sterilizing jars.
5. Heating fruit.
6. Covering jars.
7. Testing jars.

Application.

Suggest that the girls try canning some fruits at home during the summer or have them report on the methods their mothers use.

2. Encouraging home gardening

Much can be done on the part of the teacher to arouse the interest of the children and to encourage them to plant a garden. One lesson may be given on why the children would like to have a garden. During the winter the teacher should send to a number of seed firms for catalogues. The pictures found here may be used to interest the children and to help them decide what to plant. The topics are so arranged in the outline in the last chapter that the plants specially suggested for planting in spring are the ones that have been studied the previous fall. These points may be briefly reviewed to lead the children up to the matter of planting these seeds. It is not expected that the children will plant only the seeds here suggested, but they should be encouraged to include these in their list, because the seeds have been so apportioned in the various grades as to include the most common types of flowers and vegetables, so that if the child raises those suggested each year he will have a fair idea of a great variety of plants.

Charts for primary grades. A great variety of charts may be made in connection with the subject of gardening. For making the charts a large piece of heavy paper will be needed. Each chart should represent some specific idea. Oftentimes the heading may be printed across the top of the chart in large letters, such as the following: "Vegetables that grow below the ground"; "Vegetables whose leaves we eat"; "Flowers from mother's garden"; "Fruits that are raised in our State." The purpose of the chart is explained to the children and they are asked to bring appropriate pictures. Catalogues of seedsmen and advertisements in magazines and papers will furnish abundance of material. The children may cut out the pictures and paste them on the chart.

Penny packets of seeds. One way to induce the children to start a garden is to give them an opportunity to secure seeds at a penny a packet. A number of firms are now selling seeds to children at this rate. One of the best-known is the Children's Flower Mission, of Cleveland, Ohio. The teacher sends to the firm asking for as many order blanks as she thinks she can use. Or a better way is for all the teachers in a building or in a town to send together. These blanks are sent free. They are given out to the children, who take them home and, after talking the matter over with their parents, fill out the blanks and bring them to school with the money. The blanks and money are sent to Cleveland, and after a short time the seeds are sent back to correspond with the orders. The express is paid by the firm, so that the teacher has no expenses involved. After the children have bought their seeds, they will usually plant them and care for the plants. At the proper time lessons should be given on the various steps in gardening.

Plans of gardens. In the late winter or early spring the teacher may help the children make plans of their gardens. Each child should draw on a paper lines to represent the boundaries of his garden. On this may be drawn lines to represent rows, and on these may be written the names of the seeds to be planted and the distances between the rows. In this way the child can plan just what he is to plant, and how many rows of each vegetable, so that his plans may be made to agree with the size of his garden.

A second lesson may be given on the preparation of the soil. The two chief things to consider here are the enrichment of the soil by fertilizer or manure and the spading of the soil and getting it ready for the seeds.

A third lesson may be given on how to plant seeds. This may be worked out as follows: —

TOPIC: PLANTING SEEDS (SPRING)

Materials: Box of dirt, seeds, hand weeder. The children should be allowed to do the various things with the seeds and dirt as the lesson progresses.

Child's problem.

What is the proper way to plant radish seeds?

Outline of development.

1. Getting soil fine.
2. Depth of planting seed.
3. Distance apart.
   A. Between rows.
   B. In rows.
4. Time of planting.
5. Covering.
6. Firming soil.

Application.

This lesson should be given at the proper time for planting seeds outdoors, so that the children may plant seeds at once in their home gardens.

Correlated work.

Literature.

Lovejoy, *Nature in Verse*, page 14.

Lovejoy, *Poetry of the Seasons*, page 45.

McMurry and Cook, *Songs of Tree-Top and Meadow*, pages 12, 110.

Transplanting and thinning. When the time comes for transplanting and thinning, lessons should be given on the proper way to do them, using seedlings raised in the schoolroom as a result of the previous lesson. These lessons should be given at the proper time to do the work outdoors, so that the children may apply the lessons at once. The teacher should ask the children about their gardens and remind them at the appropriate times of the things to be done.

Garden calendar. Additional interest may be aroused in the garden work by keeping a garden calendar on which

the children may record the happenings in their garden. In its simplest form it may consist of the following columns: —

Garden activity observed	*Date*	*Name of child first reporting*

3. House plants in the schoolroom

Flowers from bulbs. One of the most satisfactory means of securing flowers in the winter is through the use of bulbs. All the work can be done by the children and the whole cycle may be carried on during the school year. These bulbs may be started at any time in the autumn or early winter. For this purpose secure some flower pots, — six inches or larger, — ordinary garden soil, and bulbs. The drainage holes in the flower pots should be covered with something which will allow the water to drain out, but keep the soil in. Fill with dirt to within a half-inch of the top and plant the bulb so that the tip is barely covered. Water it thoroughly. The pot must be put in a location that meets two requirements; it must be dark and cold. The Chinese lily, paper-white narcissus, and Roman hyacinth cannot stand freezing, but the daffodil and Dutch hyacinth can. Usually some place can be found in the basement, but it must not be where the furnace keeps it warm. Bulbs that can stand freezing may be placed outdoors on a board and covered with leaves or straw with some weight to keep them on. During this period the soil must be kept moist. Usually if they are well watered when put away and then kept covered, this watering will be sufficient.

During this period a root system is forming, so that when the plant is brought into a light, warm room, the stem grows

quickly. The length of time required for these roots to form varies according to the bulb. The time to keep out the various bulbs before they may be brought in is given below in a table. This is the least time. They may be kept as much longer as desired. When brought in, they should be cared for like any ordinary house plant.

A convenient way for school use is to put the bulbs away in October or November, and bring them in just after the Christmas vacation. The bulbs which the author has found most satisfactory for school use are given below. In order to secure a continuous succession of bloom, either different kinds of bulbs may be chosen, or the same kind may be brought in at different times.

Name	*Time to keep in dark*	*Time to bloom after brought to light*	*Time remaining in bloom*
Chinese lily	2 weeks	5–6 weeks	3 weeks
Paper-white narcissus	5– 6 weeks	5–6 weeks	3–4 weeks
White Roman hyacinth	7– 8 weeks	3–4 weeks	3–4 weeks
Daffodils	8–12 weeks	4–6 weeks	2–3 weeks
Dutch hyacinth	10–11 weeks	6–7 weeks	2 weeks

Chinese lily in pebbles. The Chinese lily may be very successfully grown in a dish containing some pebbles and water. A shallow dish is half filled with pebbles and the bulbs are placed among them so as to be supported by them. Water is added till it touches the bottom of the bulb. The dish is placed in a dark closet for about two weeks, during which time the roots grow, and then the dish is brought to the light. Water should be added occasionally so as to keep the base of the bulb wet.

Window boxes. To grow house plants in the schoolroom large flower pots or window boxes may be used. These window boxes can be made by the boys in the manual-training department. Among the best plants to grow in the schoolroom are ferns, asparagus sprengeri, and geraniums. For shady situations, aspidistra, begonia, English ivy, oxalis, and primroses also do well. Heliotrope, wandering Jew, and fuchsia are well adapted for sunny locations. The chief things to consider in the care of house plants are to keep them watered and to protect them on cold winter nights.

Propagation of house plants. Geraniums may be easily raised by means of soft-wood cuttings taken from the growing part of the stem. If only a few cuttings are to be raised, an ordinary flower pot may be used. This should be partly filled with clean moist sand well pressed down. To make the cutting, a growing tip two to four inches long is cut just below a node. The lower leaves are removed so as to leave at least an inch of free stem. To reduce the evaporating surface still more, it is well to cut off about half of each of the remaining leaves. By means of a knife an incision is made in the sand, and into this the cutting is inserted for about an inch and the sand pressed firmly about it. To prevent too much evaporation a glass jar or tumbler is inverted over the cutting, leaving it raised a trifle on one side to admit air. The sand should be kept moist. The cutting should be left till new leaves begin to form. This is evidence that new roots have formed and the plant may be then transplanted.

If it is desired to raise a large number of cuttings, a window box may be used in place of the flower pot. This may be covered with a pane of glass.

Other plants that may be raised in this way are wandering Jew, begonia, carnation, chrysanthemum, coleus, rose, and fuchsia.

Cuttings of the wandering Jew and of some geraniums may be successfully started in a tumbler filled with water, and then transplanted after the roots have formed.

This work can all be done by the children, and after the cuttings have become well started in the schoolroom, they may be taken home by the children and cared for.

4. Experiments with plants

A. Raising plants. A great amount of interesting and instructive work can be done with seeds and seedlings in the schoolroom. But this work should all be done with a definite purpose. It is not sufficient merely to plant seeds and then let the seedlings die from neglect. The work should be clearly motivated from the start. The following purposes are suggested to guide this work: —

1. To raise mature plants and secure the products in the schoolroom. Radishes may be matured here large enough to eat, and nasturtium flowers may be secured.
2. To raise seedlings early in the season so that later they may be taken home and transplanted in the children's gardens. Among those that can be raised in this way are lettuce, cabbage, tomatoes, and a great variety of flowers.
3. To see the changes that take place in the parts of the seed and seedlings as the plant grows. Have some device by means of which the growth of the root may be watched. One very simple way is to take a tumbler and roll up a piece of blotting-paper so that it just fits the tumbler. Fill the space in the center of the blotting-paper with moist sand. Plant some seeds, such as peas, corn, or beans, between the blotting-paper and the glass.

Another way is to put a piece of wet blotting-paper in a plate. On this put some seeds, then cover with another

piece of moist blotting-paper and invert another plate over this. When it is desired to watch the progress of the seeds, the plate and the blotting-paper may be lifted.

Another interesting device which enables one to watch the early stages of growth is a pocket garden which the children can make. Secure two pieces of glass the same size (old negatives are very satisfactory) and a piece of blotting-paper the same size as the glass. Moisten the paper and lay it on one of the pieces of glass. On this put a few small seeds, such as radish or lettuce. Cut some narrow strips of blotting-paper and place them around the edge of the large piece two deep, so as to form an enclosure. Put the other piece of glass over this and slip on a couple of rubber bands to hold all together. When the paper becomes dry, stand the glass on edge in some water for a few minutes. Plants may be grown for two weeks in this little pocket garden.

Have the children make a series of drawings, showing the changes in the seeds and seedlings. First soak some beans overnight. Let the children open them and draw the parts of the seed. Have another drawing made when the root first comes out of the seed. One drawing should show the seedling just as it first comes through the soil. Other drawings should be made whenever any noticeable change occurs in the seedling. These drawings should be placed side by side on a large sheet of paper or else arranged in a little booklet. The date should be placed under each drawing. These drawings may be made either with ordinary pencil, colored crayons, or water-colors. Children are more interested to work with colors.

4. Eggshell garden. The young children will be much interested in an eggshell garden. Each child is asked to bring an eggshell to school. On the outside of each shell is written the name of the child. A hole is punched in the

bottom of the shell for drainage and the shell filled with soil. Each child plants some small seeds in his shell. Different children may plant different seeds. Among the best to plant are pepper-grass, lettuce, radish, cabbage, wheat, and buckwheat. The eggshells may be kept in a pan filled with soil or sawdust.

B. Germination experiments. Another set of studies may be carried on to learn some facts regarding germination.

1. *To show the conditions needed for germination.*
   a. To show the conditions of moisture, put some blotting-paper in the bottom of three tumblers. Moisten one slightly, a second moderately, and the third so that a little water stands on the paper. Put seeds in each tumbler and cover by putting another tumbler over each. Allow to stand for a week or longer and note the differences in the three tumblers.
   b. To show that air is necessary, fill one tumbler half full of water and in another put a moist piece of blotting-paper. Put seeds in both tumblers. Keep the paper in the second tumbler moist and allow to stand.
2. *To learn the best depth at which to plant seeds.*

Fill a shallow box about seven or eight inches deep with soil. In one corner plant three seeds of lettuce, three of radish, and three of peas one inch deep. In a second corner, plant three of each, two inches deep; in a third corner plant three of each, four inches deep; in the fourth corner plant three of each six inches deep. Mark on each corner the depth planted. Keep the soil moist. Record the time when the first plants of each kind appear in each corner. Record in the form of a table on the board. At which depth do the plants first come up? At which depth do most come up? Is

there any depth at which none come up? The experiment may also be performed in a quart canning-jar. The jar is filled with sand and the seeds planted at varying depths next to the glass. This allows their growth to be watched.

3. *To test the vitality of seeds to see what per cent will germinate.*

Lay a piece of moist blotting-paper or cloth on a plate. Mark it off into squares. In each square put the various seeds to be tested, taking a larger number for the smaller seeds. Count them. Cover with another piece of moist blotting-paper or cloth. Invert another plate over this. Allow to stand for a couple of weeks, keeping the paper moist. Figure out the percentage of each kind of seed that germinates.

4. *To learn how the squash seedlings get out of the seed coat.*

Take the same kind of apparatus as that described in the last experiment. Plant some squash seeds in it. Examine every day. Have the children make drawings of the different stages till the seedling is free from the seed coat.

5. *To learn what becomes of the cotyledons when the seed germinates.*

Plant some seeds of peas and beans in a box or tumbler filled with soil or saw dust. When the plants are an inch or two high, carefully pull up the whole plant and find the cotyledons. The children may make a drawing showing the difference.

C. Work of roots.

1. *Root hairs.* The work of absorbing moisture is done by the root hairs. To show these, put two thicknesses of moist blotting-paper in the bottom of a tumbler. On this place a few radish seeds. Cover with another tumbler. Keep the paper moist. Notice the location

and variation in the length of the root hairs. Have the children draw the root hairs.

2. *Direction of growth.* In order to show the direction in which the root of a seedling grows, plant some radish seeds in the pocket garden described on page 130. Stand the garden on edge. When the roots are about a half-inch long, turn the garden one fourth way round. Notice the effect on the tip of the root and how long it takes before the effect is shown. Turn through another ninety degrees and allow to stand for a day. Turn several times more. Have the children make drawings showing the various positions of the root.
3. *Food storage in roots — carrot basket.* Some roots serve the purpose of storing food. This may be nicely illustrated by making a carrot basket. Cut a carrot in two crosswise about in the middle. Take the top half and hollow out the center from the cut end, leaving a shell of the root around the outside. Fill this with water. Suspend this by means of strings or wires in the window. Keep the carrot filled with water and in a short time the leaves will begin to grow out and will curve up around the carrot making a very attractive object.

D. Work of the stem.

1. *Passage of sap up the stem.* The two chief duties of the stem are to conduct liquids and to hold up the leaves to the sunlight. To show the work in conducting liquids, take a piece of a twig of a tree about the size of a lead pencil and put one end in red ink. Allow to stand for a few hours. Then with a jack-knife make sections across the part of the stem that was above the ink. The red ring shows where the sap goes up the stem.
2. *Direction of growth.* Plant some sunflower seed in a flower pot filled with soil. When the young plants are

about three inches high, place the flower pot on its side and allow to remain a few days. Notice the direction of growth of the stem.

E. Work of the leaf. The two chief duties of the leaf are transpiration and starch-making. To show the passage of water through the leaf, put the end of a spray of leaves into some red ink. Notice through what parts of the leaf the red ink passes.

1. *Transpiration.* To show transpiration, fill a tumbler with water; over it put a piece of paper. Make a hole in the center of the paper and put the stem of a large leaf through it. Invert a clean tumbler over the leaf and put in a sunny position. Notice what forms on the sides of the tumbler. How long does it take before it begins to form? Put in a shady place and see how long it takes.
2. *Light and starch-making.* Experiments to illustrate the process of starch-making are too difficult to perform in the ordinary schoolroom, but one simple experiment may be performed out of doors to show the need of sunlight in the process of starch-making. Put a piece of board on the grass. At the end of a week lift the board and look at the grass. What change has taken place? Remove the board and notice the grass at the end of another week. What does this experiment show?
3. *Leaf exposure to sunlight.* Notice the tips of both horizontal and vertical branches on the elm and maple. Note the position of the leaf surface with reference to the light, and note how the petioles help the surfaces to attain this position. Some of these branches may be cut off and brought into the schoolroom to study. Notice also the position of leaves of a vine growing on a building.

CHAPTER XIII

LESSONS WITH WEEDS

Motivation. Weeds touch the child's life in three ways: they are one of the most common forms of plant life that he sees on every hand; they are an enemy of his garden; and some weeds are poisonous either to touch or to taste. These three points of contact suggest the lines along which the work with weeds may proceed: the identification and control of common weeds. The application is found in the ability of the child to go out and name the common weeds, and in his applying proper methods to control the weeds in his garden.

Collections. Weeds are so common that there is no trouble in securing an abundance of materials. An interesting line of work is to have two types of collections made, one of the plants and one of the seeds. In starting a collection some definite problem should be suggested, such as to make a collection of the weeds found in the garden, or those found by the roadside, or in vacant lots, or in the cornfield. The plants may be pressed the same as leaves, as explained on page 90.

To mount the weeds secure pieces of heavy paper or light cardboard of some uniform size. Place the weed on this and fasten it by means of narrow strips of gummed paper, which should be put over the parts of the plants in several places and stuck to the cardboard. Beneath each specimen write the name of the plant, the place where collected, and other points of interest.

If one wishes a more permanent mount, a piece of glass may be placed over the specimen and the glass and card-

board fastened together around the edge with passe-partout binding paper.

In a few years a collection of most of the common weeds may be obtained. In case any specimens of either plants or seeds cannot be identified by means of the books at hand, they may be sent to the State Agricultural College.

Seed collections. Collections may also be made of weed seeds. These may be placed in small vials, which can be mounted on cardboard. Another very satisfactory method of keeping the seeds is to mount them between two pieces of glass. For this purpose secure two pieces of glass of the same size (old negatives serve the purpose nicely), and a piece of cardboard of the same size, but of extra thickness. Plaster-board sold at the lumber dealers, or tarboard obtainable at the printing offices, may be used. In this bore a series of holes in regular order about one-half inch in diameter. In order to get the holes clean-cut, after boring partway through on one side of the cardboard, remove the bit and finish the hole by boring from the other side. The holes may also be made by a gun punch used in cutting wads for shells. Glue a piece of white paper to one side of the cardboard.

When as many kinds of seeds have been collected as there are holes in the cardboard, place a piece of glass on the table, and on the glass put the cardboard. Place the weed seeds in the holes and write the name below each hole. Then put the other piece of glass on top and bind the two pieces together at the edges with passe-partout binding paper or adhesive tape. This gives a very convenient mount. It is compact and the seeds can easily be seen and examined with a magnifying glass. The Specialty Manufacturing Company, St. Paul, Minnesota, sells for fifteen cents a complete outfit of this kind for mounting twenty-four kinds of seeds.

Cases of weed seeds mounted in this way have been put up for sale by the Weed Seed Laboratory, State Agricultural College, St. Paul, Minnesota. Each case contains twenty-four kinds of seeds. So far four cases have been mounted. The price is fifty cents per case. These are very helpful in identifying the seeds that the children bring. Perhaps the children might be interested to raise the money in some way to buy the cases, or they might be bought by the school board.

Correlation. There are many opportunities for correlation in connection with art in having the children make drawings of the various parts of the plant. It adds interest to have the children make booklets, in which may be kept a series of drawings of different weeds. Small pieces of the weed plant may be pressed and mounted in these booklets together with the drawings. If desired, the language work may be correlated here and brief compositions on weeds may be kept in the same booklet.

Arithmetic. A number of problems relative to the reproductive power of weeds may be given.

1. It has been estimated that a single plant of pigweed may produce 300,000 seeds. If each seed grows to form a plant bearing the same number of seeds and this continued year after year, how many seeds would there be at the end of the fifth season?
2. A single plant of Indian mallow was found to produce 2480 seeds, and to cover 315 square inches of space. If each seed should form a plant of the average size bearing the above number of seeds, how much space would these plants cover the next season? How much space the season following this?
3. Take some common weed and estimate the number of seeds it produces and the area covered by one plant, and then compute the area covered by its descendants at the end of the third season.

Most of the work with weeds is best carried on in the grammar grades, although a little might be done in the

upper intermediate grades. The autumn is the best time on account of the great abundance of material at that time. In the spring, when the gardens are started, attention may be called to the best methods of keeping weeds out of the garden.

Following is a brief outline of the main points to be brought out in the study of a particular weed: —

1. Identification.
   - A. By size and general form.
   - B. By leaves.
   - C. By flowers.
   - D. By fruit.
   - E. By habits of growth.
2. Harm done.
3. Kind (annual, biennial, or perennial).
4. Troublesome characters of seeds.
   - A. Number on a plant.
   - B. Adaptation for dispersal.
   - C. Number of years retain vitality.
5. Means of control.

Lessons on weeds

Topic: Poison Ivy

Materials: Leaves and fruit (if in season) of woodbine and poison ivy. The leaf of the ivy may be collected with gloves on and put into a glass jar and the cover put on. It will be better if a field trip can be taken.

Child's problem.

How may we tell poison ivy from woodbine, so that we may avoid being poisoned by it?

Outline of development.

1. Places where they grow.
2. Leaves.
   - A. Number of leaflets.
   - B. Margin of leaflets.
   - C. Size and shape of leaflets.
   - D. Petioles.

3. Color of fruit.
4. Height to which plant grows.

Application.

Ask the children to be on the watch for ivy, and if they see any to report to the class where. Have a map made of the vicinity of the school and on this mark the places where the ivy grows. Have a collection of poisonous plants made.

Correlated work.

Art.

Have the children make drawing of the two leaves side by side.

This should be followed by another lesson on what to do in case of poisoning by ivy.

Topics: Pigweed and Lamb's Quarters (Autumn)

Materials: Specimen of a whole plant of each; several specimens of leaves and fruit.

Child's problem.

How may the rough pigweed and lamb's quarters be told apart?

Outline of development.

1. Differences in leaves.
2. In fruit.
3. In seeds.
4. In form of plant.

Application.

Ask the children to bring a leaf of each kind of plant. Have a collection made of weeds of the garden (both plants and seeds).

Correlated work.

Art.

Have drawings made of leaves of both plants; also of seeds enlarged as seen under a magnifying glass.

Topic: Number of Seeds on a Plant (Autumn)

Child's problem.

How many seeds does a single plant of burdock (or other plant) produce?

Materials and method: Have an entire plant of several kinds of weeds brought into the schoolroom. Divide the children into as many groups as there are kinds of weeds to be studied, and distribute among them portions of the plant. Or if the plant is a large one, the whole school may work on the same plant. Show them how to count a small portion carefully, and then estimate the proportions of the whole that this part is. Put the results on the board and add all together, so as to get the total number of seeds on the plant.

Correlated work.

Arithmetic.

Ask them to determine for each plant the number of seeds that might be produced in three years if all the seeds grew and bore the same number of plants as this one.

Application.

Ask each child to find a plant outdoors like the one he has been studying and estimate the area of ground it covers. Take the average of the reports given by the children. Then ask them to figure out what area would be occupied by the plants growing from the seeds on a single plant? What area the next season following?

To show the part that birds play in eating weed seeds, have the children gather the same kind of weeds in the spring and estimate the number of seeds found then. When the weeds are gathered, look closely on the ground beneath to see if many seeds are found.

Seeds in soil. To show the abundance of weed seeds in almost all kinds of soils, have small quantities of soils brought in from a variety of situations: from the garden; from the edge of a pond; from different levels in a cellar that is being dug; from the roadside; from a vacant lot, etc. Place in separate flower pots. Keep in a warm place, water the soil, and notice how many plants come up.

PART IV
HYGIENE

CHAPTER XIV

PRINCIPLES UNDERLYING THE TEACHING OF HYGIENE

Importance. The importance of health in everything that one undertakes in life, and hence the supreme importance of teaching boys and girls how to care for their health, is self-evident. Hygiene is the most important subject in the school curriculum. All that the child may learn about history and geography fades into insignificance compared with the tremendous value of health. And yet, in spite of its overshadowing importance, it is one of the most neglected subjects in the curriculum. It is a sad reflection upon the efficiency of our school system that the most vital subject should receive so little attention.

Results in the past. It seems to be the general consensus of opinion of careful observers that the teaching of physiology and hygiene in the schools has largely been a failure, when judged by the results obtained in the lives of the children. If the teaching of hygiene is to be effective, it must show its effect upon the habits of living practiced by boys and girls. Judged on this basis, physiology teaching has not proved successful.

As a definite illustration of this fact the following figures will be of interest. Dr. Hoag was employed by the Minnesota State Board of Health to travel through the State and visit the schools to ascertain the general health conditions and to recommend remedies. In the towns that he visited, he secured information regarding the health habits of the children. When the results obtained from several thousand children in a number of cities and towns were tabulated, the following figures were found: —

Thirty-seven per cent had no ventilation of bedroom.
Only nineteen per cent used a toothbrush daily.
Nine per cent used a common toothbrush.
Fifty per cent had never been to a dentist.
Seventy-one per cent used coffee daily.
Eighty-two had no fruit for breakfast.

The conditions found in each of the towns were approximately the same. When one considers the appalling lack of proper habits regarding the great essentials of air, food, and cleanliness displayed by these results, the crying need of teaching children the proper habits of living is very evident.

Another indication that the American people are not following hygienic habits of living is found in the fact that the death-rate for people over forty years of age is increasing in the United States, although it is decreasing in Europe.

Causes for failure. It is not difficult to find some of the reasons for the failure of physiology teaching. In the first place, it has been anatomy and physiology that have been taught, and not hygiene, and so the whole point has been missed. Teachers are frequently not prepared to teach the subject and dislike it, and this feeling is caught by the children. The excuse has sometimes been given that time enough could not be found to teach it. This, of course, simply shows lack of understanding of the importance of the subject. The most important things must be taught, and minor things must give way.

Many of the textbooks used have been poorly adapted to the child in every way, in the topics treated and in the method of treatment. In some cases an excessive amount of time devoted to temperance physiology has given the children a dislike for the subject, and has given a wrong perspective of the whole subject of hygiene.

Essentials for good teaching: (*1*) *Formation of proper habits.* We will now pass from negative to positive considera-

tions, and discuss some of the things essential for the successful teaching of hygiene. First and foremost, and always to be kept in mind by the teacher, is the fact that the purpose of teaching hygiene is to help the child to form proper habits of living. The only and sole purpose of the subject is to teach the child how to look after his health and that of the community. Any teaching of hygiene that does not have this purpose must necessarily be a failure; and any teaching that does not procure this result is a failure. Habit formation, then, is the keynote. The mere giving of information is valuable only so far as it helps in the forming of habits; but simply to give the child information about hygiene which he does not apply falls wide of the mark. The child should be taught how to do, rather than why.

This is especially true of the lower grades, as very little work in the formal teaching of hygiene by set lessons can be done. But much can be done to help the children to form correct habits. The actual results obtained depend partly upon the home influences. If the parents coöperate with the teacher, much good can be done; if the parents are indifferent, less can be accomplished, but still something can be done.

Home habits. The following are the more essential habits of hygiene that the teacher should try to have the children acquire: (1) washing hands before eating; (2) thorough mastication of food; (3) abstaining from tea and coffee; (4) cleaning teeth daily; (5) retiring early; (6) ventilation of sleeping-room; (7) playing out of doors regularly; (8) care of the eyes in reading.

Simply to give a lesson on each of these habits is not enough; it is but the initial step. The child's habits must be followed from week to week. Frequently the teacher should have the children report on the extent to which they are doing the things suggested, and in many ways the

teacher should seek to call the matter to their attention. The secret of success in forming habits is constant repetition.

School habits. There are some habits which the teacher can directly supervise in the schoolroom, such as the following: (1) correct posture; (2) use of eyes; (3) cleanliness of hands, face, and clothing; (4) use of individual towels. These come under the constant supervision of the teacher, and these matters should often be brought to the attention of the children till the correct habits are formed.

Habits to discourage. There are often some bad habits which children acquire that the teacher should discourage and try to break up; such as: (1) putting things in the ear, and using objects like hairpins to clean the ear; (2) expectorating on the floor; (3) coughing in other people's faces; (4) reading in dim light; (5) putting objects in the mouth. In order to break up a habit, the teacher must frequently call the attention of the children to it and get them to thinking about it, instead of doing it automatically.

The teacher must realize at the start the fundamental importance of the subject, and must let nothing swerve her from the main purpose. It is a difficult matter to form health habits and requires constant and continued effort on the part of both the teacher and child till the habit is formed. Mere knowledge of a fact does not mean that the child will apply it. Further suggestions by the teacher are needed to help the child act.

(*2*) *Teacher's habits.* The teacher herself must have the proper habits of living, both for her own sake that she may make the most of life, and for the sake of the children that her example may be a model for the children to follow.

(*3*) *Hygiene, not anatomy and physiology.* The thing to emphasize is hygiene, and not anatomy and physiology. The human body is too complicated a mechanism for the

pupil to understand, in the first place; and furthermore, knowledge of anatomy and physiology has practically no influence on the formation of health habits. The time to form these habits is when the child is very young, in the primary grade, and when he cannot understand even the reasons for them; but the thing to do is to get the habit formed. In carrying on actions by habits the child does not have time to think; if he did, the action would cease to be a habit. Anatomy has no place whatever in the elementary schools, and physiology only a very minor place, such that the child may understand in a very general way the purpose of the heart, stomach, and other organs of the body. How absurd to-day seem the old methods of attempting to teach the care of the body by having the children learn the names of the bones, and having them trace on a chart the circulation of the blood.

(*4*) *Emphasis on positive side.* The positive side of good health should be emphasized, rather than the negative side of disease. The child should have held up before him the ideals of good health and the value of health in everything that he wishes to do. He should be led into good habits by the desire to attain good results, not by the fear of ill results. This statement is based on a well-known truth in psychology, that a stronger appeal can be made to a child through desire than through fear. Too much emphasis on the disease side and the ill effects of improper habits of living may produce a morbid feeling that is distinctly injurious.

(*5*) *Both personal and public hygiene to be taught.* But the entire emphasis should not be laid on personal hygiene. In the earlier years special attention may be given to forming correct personal habits. In the later years special consideration should be given to the health of the community. Attention should be called to those matters in which all are equally concerned and for which all must coöperate,

such as the public water supply, the milk supply, the food supply, and the control of contagious diseases. The child is to work not merely for himself, but for others as well. And, of course, this emphasis on public hygiene eventually gets back to a renewed emphasis on personal hygiene; but it is from a new standpoint, that of the relation of these habits to the welfare of other people; so that the child has a double incentive for correct living, for himself and for others.

(*6*) *Constant supervision.* Hygiene should be taught, not as an isolated subject that comes at a certain period of the day and then is forgotten, but as a constant part of all the daily school life of the child. At any and every part of the day that any point of hygiene is involved, then should the teacher see that the proper thing is done. The habits of the child should be under constant supervision by the teacher at all times.

Motivation. One of the first essentials in teaching is to arouse the children's interest. How may this be done in hygiene? At the outset we meet a discouraging fact, but one which we must face, namely, that children have little or no interest in health as an aim in itself. This being the case, we must find some interests which can be used indirectly to promote health habits. All possible interests, both direct and indirect, must be found in the present activities of the child. The child is not interested in the dim and distant future. To seek to interest a child in what may happen in his life ten or even five years ahead means nothing to him. It makes no appeal to him. Our appeal must be made to the present.

There are a number of ways in which the interests of the child may be appealed to and used indirectly in teaching hygiene. Among these are the following: play instincts, desire for teacher's approval, competition, imitation, dramatization, and grading pupils on habits rather than knowledge.

(*1*) *Play and exercise.* It is a very easy matter to get the child to acquire habits of exercise through play. This instinct is very strong and forms a large part of the child's life. It simply needs to be encouraged and guided into those kinds of plays that require exercise and take the child out of doors. No attempt will be made here to suggest any specific games, as there are a number of books that go into this matter quite fully.

(*2*) *Teacher's approval.* If there exists the right feeling of friendliness and coöperation between the teacher and child, he will be glad to do things to please the teacher. And if he has confidence in her, he may be led to do certain things which the teacher tells him are best for him to do, even if he does not understand the reasons for doing them. The teacher may use this spirit to help the child in forming desirable habits.

(*3*) *Competition.* Competition is always more or less of an element all through the child's life. While this may be carried to an extreme, it has its place and may be used by the teacher in teaching hygiene. After the teacher has made clear to the children what the desirable habits of hygiene are, she may stimulate a little emulation in the children, as is often profitably done in other subjects. She might have a roll of honor list on the board, and those who have done certain things for a week would have their names placed there. Or all the names might be placed on the board and stars put after each name, whenever certain things at home or school had been done, such as cleaning the teeth or going without coffee. The children's hands may be examined each morning to see which have the cleanest hands. Competition may be started between the different rows to see which row can keep their teeth the cleanest. Similarly, other desirable habits may be taken, and other similar devices will suggest themselves.

(4) *Imitation.* Imitation is one of the commonest methods by which the child acquires habits. This is usually unconscious on the part of both the child and the one who is being imitated. Here is one of the strongest reasons, from the school standpoint, why the teacher herself should have correct habits of living. The children will unconsciously imitate her, and, if her habits do not correspond with the teaching, little good can be done. But if they do harmonize, this will make another link in the chain which is helping the children form correct habits. The teacher may find some person whom the child particularly admires, and he may thus be stimulated to imitate desirable habits that this person may possess.

(5) *Dramatization.* Dramatization is a very powerful means of interesting children and teaching various lessons, as this involves the play instinct. In case of those activities which occur at home, the children may play the various parts as they should be done. To show how to use the eyes in reading, a table may be arranged to represent a home circle and various children may take the part of father, mother, and children. The parents may then show the children how they should sit with reference to the light. The part may be played again by other children.

To teach some of the rules of eating, a table may be supposed to be set with various foods, which may be indicated by pieces of paper with names of food written on them. Two children may represent the parents and may take the responsibility to see that others who act as their children take the right kinds of food. Mistakes should be corrected.

In a similar way other habits may be acted out, such as opening a window before going to bed. The child may take a toothbrush and tumbler and go through the motions of cleaning his teeth. The girls may show how to care for food, and how to keep the house clean. Certain children

who take the part of parents may give lessons in their own language to other pupils playing the part of their children. They may be allowed to write a drama of their own and present it.

Treatment for emergencies may be acted out by supposing that some child in the room has met with an accident, and having the other children treat him.

Fifteen playlets for children on health subjects have been prepared by the National Association for the Study of Tuberculosis, whose address is given on page 152.

(6) *Credit for habits.* The child should be judged and graded, if grading must be done, not by what he knows about the subject, but by what he does. The child's habits at school should be watched, and the extent to which he is carrying out proper habits at home should be learned by observation and by questioning, and the child graded accordingly. This will be one stimulus to help him acquire proper habits. This is an extension in one particular field of a principle which is receiving recognition in many schools, namely, giving school credit for home work. And so here we may give credit for home habits. Perhaps, to begin with, the grades might be based half on the child's knowledge, in case a textbook is used, and half on his application of this knowledge.

On page 152 is given a health record that the author has used successfully in the intermediate grades. The time for retiring will vary according to the grade.

Each child fills out his blank with the assistance of the parents, who sign the record at the end of each week. These blanks are then brought to school.

In order to arouse interest and stimulate competition a Health League was formed by the different rooms using this record. The average grade of all the children in each room was taken weekly. An appropriate chart was posted in a conspicuous place and on this were written the names

RECORD OF HEALTH HABITS

	Daily credit	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*	*Sunday*
Wash hands before each meal	16							
Do not use tea or coffee	16							
Clean teeth daily	16							
Exercise one hour outdoors	16							
Sleep with window open	16							
Retire before 9:00	16							
Bathe once a week	4							
Total	100							

I believe this report to be a truthful statement of my child's habits for the week. (To be signed by parent.)

of the rooms and their averages, the highest first. A hygiene banner was provided and the class having the highest average kept the banner in its room for a week. New averages were made up at the beginning of each week and the banner awarded accordingly.

The reports of the parents and teachers indicated that the plan was eminently successful.

An organization known as the "Modern Health Crusaders" has recently been formed, as a means of inducing children to form hygienic habits of living. There has been published a list of health chores, somewhat similar to those given in the above health record. Children who perform eighty per cent of these chores for certain periods of time receive various titles according to the length of the period that the chores are done. At the beginning of 1918 this organization had a membership of several hundred thousand.

Full particulars may be obtained by writing "The National Association for the Study and Prevention of Tuberculosis," 105 East 22d Street, New York City.

Science method. Another way to arouse interest is to use the science approach and method in teaching the lessons on hygiene. As far as possible provide concrete material which the child can study, and with which experiments may be

performed. In studying the hygiene of breathing and ventilation, perform some simple experiments showing the composition and pressure of air, and then pass to the hygiene of air. The study of water may be introduced by experiments showing some properties of water, and the changes in state through which water passes. Foods may be brought into the schoolroom and tested for their constituents, fats, proteins, and carbo-hydrates. In each of these cases, having aroused the interest of the children in the general topic by means of concrete experiments, the hygienic applications of the topic may then be presented to the children. In chapter XV more definite suggestions are given along this line.

Work in primary grades. As we have already seen, the chief thing in the primary grades is to encourage the formation of health habits. One of the best ways to encourage these is a frequent inspection of each pupil. This may be given several times a week, or perhaps every day. The children may be taken in rows and examined a row at a time for the following features: (1) cleanliness of hands and nails; (2) cleanliness of face and ears; (3) cleanliness of teeth; (4) cleanliness of clothing; (5) care of hair. Those who are very unclean may be sent to the washroom to get cleaned up. As a stimulus for keeping clean, perhaps those who are generally unclean may be put in a division by themselves and called the "unclean" or "careless" squad, till they deserve promotion by being more careful. The exact things to be done must depend on the homes from which the children come. The teacher must use tact, as the condition of the child usually reflects the ideals of the home.

Hygiene charts. One very effective way of arousing the child's interest and leading his attention to certain desirable habits is the construction of hygiene charts by the children.

Following are suggested some possible topics for each of which a chart may be worked out: —

How to Keep Clean.
A Good Breakfast, or Dinner, or Supper.
Good Drinks for Children.
How to Get Fresh Air.
How to Get Exercise.
How to Clean the Teeth.
Where my Mittens Came From.

In some schools toothbrush drills are given, in which the children are shown how to brush their teeth.

Work in intermediate grades. In the lower intermediate grades the work may proceed along lines similar to those followed in the primary grades, but the work should be extended to meet the growing capacity of the child, and oral lessons on hygiene given in the fourth and fifth grades. Some of the simple experiments given in chapter XV may be performed in the intermediate grades. In the sixth grade a simple textbook on personal hygiene may be used.

Textbooks. Great care should be used in selecting a textbook. Not many years ago there were no satisfactory texts really suited to grade use, but in recent years a number of really good books have appeared. A satisfactory text for the sixth grade should be written almost entirely from the standpoint of hygiene. It should contain very little if any reference to anatomy or physiology. It should be organized from the child's standpoint, and written in such simple language that the child can understand it. It should contain a large number of appropriate illustrations.

It seems desirable to use two textbooks throughout the grades, — one in the sixth grade emphasizing personal hygiene, and another in the seventh or eighth grade emphasizing public hygiene.

For books on personal hygiene, suitable for the sixth grade, the following are recommended: —

Hutchinson, *The Child's Day.* Houghton Mifflin Company, Boston.
O'Shea and Kellogg, *Health Habits.* The Macmillan Company, New York City.
Jewett, *Good Health.* Ginn & Company, Boston.

For texts on public hygiene suitable for the grammar grades the following are recommended: —

Hutchinson, *Community Hygiene.* Houghton Mifflin Company, Boston.
Coleman, *The People's Health.* The Macmillan Company, New York City.
O'Shea and Kellogg, *Health and Cleanliness.* The Macmillan Company, New York City.

Work in grammar grades. In the grammar grades the emphasis should be placed on public hygiene, with special reference to the local conditions. Some good text should be used, and the principles and suggestions there found should be applied to the immediate community. A study should be made of the health conditions in the town to see what can be done to better them, and what the children can do to help make and keep the town clean and healthful.

A bulletin board may be provided on which may be posted clippings on various topics which have been brought in by the children.

Most of the experiments suggested in chapter XV may be performed in these grades.

Special attention may be given to keeping the schoolroom and grounds in the best possible condition. Committees may be appointed to supervise certain things, such as a ventilation committee to watch the ventilation and temperature of the room, a lighting committee to watch the shades, a playground committee to care for the playground.

This might be assigned as a part of the work in hygiene, and the pupils graded accordingly. Some of the older pupils might be appointed as building inspectors to watch the thermometers in the primary rooms, in cases where this is not already being done by the janitor or by somebody else.

Outline of hygiene. A detailed outline of hygiene, arranged by grades and seasons, is given in the general outline of science in chapter XIX. Most of this is put in the winter term, because it is desired to use the autumn and spring for out-of-door studies of nature.

Temperance physiology. During the past twenty-five years considerable attention has been given in textbooks to so-called "temperance physiology," which term has been used to mean a study of the effects of alcoholic drinks on the human system. In some cases the teaching of this has been made compulsory by State laws. It seems to be the nearly universal opinion of educators that this teaching has not been based on sound pedagogy. Some of the mistakes that have been made in the past, and hence to be avoided in the future, are, first, too much emphasis on the extremes, such as the case of the drunkard, and too much emphasis on the effect on the various organs of the body, by means of charts showing pictures of the drunkard's stomach, liver, etc. Too often the teaching has been done in such a way as to leave the impression that these extreme results are the common thing, and that they always follow from the use of alcohol.

In order to make the teaching of the effects of alcohol effective, appeals must be made to the children's experiences and to their present life. To seek for a motive in what might happen in ten or fifteen years is worthless. The child is interested only in the present or immediate future. The remote possibility that the child might become a drunkard,

if he started to drink alcoholic liquors, makes no appeal to him.

The whole question of the physiological effect of alcohol is very complicated, but the child can be taught that even in small quantities it is injurious to the growing tissues of boys and girls.

The effect of the use of alcoholic liquors on the child's life may be shown in two ways. One way applies to all children. Alcohol, through causing paupers, criminals, and insane people, creates an increase in the taxes that the child's father must pay, and hence that leaves less money to be used for the needs of the child. In case a child's father uses alcohol, the effect on the family through the squandering of money, and perhaps the physical abuse of the children, may be noted as another way in which alcohol may affect the child's life. Of course, this can be discussed only in a general way before a schoolroom of children.

The disagreeable and dangerous acts of men under the influence of liquor may be cited as a thing that makes the town a less desirable place for the child to live in.

When the boy becomes of an age when he is looking for a position, then it may be pointed out to him that there are certain positions where no one will be employed who uses alcohol, and that in most other positions a person who does not drink stands a better chance than one who does. This makes a direct appeal to the boy.

Teaching hygiene by jingles and stories. Lessons in hygiene may be brought home to the child forcibly by means of jingles. The following example is taken from Dr. Allen's *Alice in Wonderland*: —

"Mary had a little cold,
It started in her head:
And everywhere that Mary went
That cold was sure to spread.

"She took it into school one day, —
There was n't any rule:
It made the children cough and sneeze,
To have that cold in school.

"The teacher tried to drive it out,
She tried hard, but — ker-choo;
It did n't do a bit of good,
'Cause teacher caught it too."

Health lessons may also be taught by means of stories. The following pamphlets relating to the care of the teeth are adapted for use with the primary and intermediate grades, and may be obtained free from the Colgate Company, New York City: *The Jungle School; Magic Pearls; Dental Lectures; Instructions for the Home Care of the Teeth.* A story, entitled *The Owchies and the Denties*, may be obtained free from the Webster Chemical Company, St. Paul, Minnesota.

CHAPTER XV

TEACHING HYGIENE THROUGH EXPERIMENTS

The science approach will make the subject of hygiene more interesting and so lead to more effective results. If concrete materials are used in connection with lessons in hygiene, these may be employed as an introduction to the application of the laws of hygiene that it is desired the child shall make. In this chapter are described a number of simple experiments that may be taken up in connection with hygiene. These are intended to be merely suggestive. Many other lessons should be worked out in connection with them, and emphasis placed on the appropriate applications. They are adapted to the grammar and upper intermediate grades. These experiments are arranged under the topics of hygiene which they most closely illustrate.

I. Breathing and Ventilation

A. Breathing

1. Composition of the air.

Apparatus: Candle, cork, plate, tumbler, lime water.

a. Get a cork stopper a little larger than the diameter of a candle. Cut off a piece about a half-inch thick from the large end. In the center cut a hole big enough to receive a short candle about an inch long. Float this in a plate filled with water. Light the candle, and after it is burning well, invert the glass tumbler over it. Allow to stand for a few minutes. Why does the candle go out? What happens to the water? The water rises to take the place of the oxygen used by the candle. The gas left in the tumbler is nitrogen.

b. To show the presence of carbon dioxide, pour some lime water in a dish and allow to stand for several hours. The white coating that forms on the surface shows the presence of carbon dioxide.

c. To show the presence of water in the air, bring into the schoolroom a metal cup containing ice water. The water that condenses on the outside of the cup comes from the air.

2. Effect on air of breathing.

How does the air we breathe out differ from the air we breathe in?

a. Breathe on the bulb of a thermometer and compare the temperature with that of the room.

b. Pour some lime water into a bottle and blow through it by means of a straw or tube. Pour some lime water into another bottle and force air through it with a bicycle pump. Which gets the milkier? What does this show?

c. Breathe on a window pane. What do the results show?

d. What three changes have taken place in the air we breathe out?

3. Rate of breathing.

While the teacher times them by a watch, have each child count the number of times he breathes in a minute. Repeat several times to find the average. Find the average for the whole class.

Try it again after the children have been taking some vigorous exercise like running.

4. Amount of air breathed.

Apparatus: A two-quart canning-jar, large pan, glass tube bent at one end, or a piece of rubber tubing with a bent piece of glass tubing inserted at one end.

a. Fill the jar with water, cover with a piece of cardboard and invert it in the pan of water without allowing the water to escape from the jar. Insert the bent end of the tube under the mouth of the jar. Have some child breathe through the tube till the water is all forced out of the jar. See how many breaths are required to fill the jar with air. Let several children try it. After each child has used the tube, cleanse the end in some disinfectant, such as hydrogen peroxide, and wash in water. From this experiment and from a previous one showing how many times one breathes in a minute, compute the amount of air that all of the children in the room breathe in during a minute.

b. For another experiment the children may test their lung capacity. Fill and invert the jar as above. After a child has taken

a deep breath, let him force out all the water he can in one breath. Record the amount on the board. Have a number of children try this.

B. Ventilation

1. Ventilation of the schoolroom.

Apparatus: Two thermometers, a piece of soft muslin, touch paper or joss sticks, tufts of down.

a. Amount of air entering. Throw a tuft of down in front of the air inlet and estimate how far it travels in a second. Do this several times and take the average for the velocity with which the air enters. Measure the length and breadth of the air inlet. Find the area and then multiply by the velocity to find the amount of air entering in a second. Find how much enters in a minute. Compare this with the amount of air that the children breathe each minute as found in a previous experiment.

b. Direction of air currents. Light a joss stick or piece of cloth and hold in different parts of the room and thus determine the direction of the air currents by means of the smoke. Make a diagram of the room on the board and indicate the air currents by means of arrows.

c. Temperature. Place a thermometer in different parts of the room and find the temperature.

d. Humidity. Fasten a piece of soft muslin cloth around the bulb of one thermometer, and allow the other end of the cloth to hang in a bottle filled with water. Hang another thermometer beside this. Fan the bulbs vigorously for a short time, then look at the reading of the wet bulb. Continue to fan till the mercury in the wet bulb ceases to go any lower. Then take the readings of both thermometers. A slight difference means a moist air; a large difference means a dry air. The percentage of humidity may be found approximately from the following table: —

Difference in readings	*Temperature (dry bulb)*				
	40	*50*	*60*	*70*	*80*
4	68%	74%	78%	81%	83%
8	37	49	58	64	68
12	8	26	39	48	54
16		5	21	33	41
20			5	19	29

To show the way of using the table, suppose the difference between the two thermometers is 16 and the reading of the dry bulb is 70, the figure opposite 16 and under 70, in this case 33, gives the per cent of humidity.

2. Conditions needed for ventilation.

Apparatus: Candle, lamp, chimney with even top, two matches, cardboard.

Light the candle. Place the chimney over it. Why does the candle go out?

Light the candle again. On each side place a match. On the matches place the chimney and cover the top with the cardboard. Why does the candle go out?

Repeat the previous experiment, except that the cardboard is not placed over the chimney. Why does the candle continue to burn? What do these experiments show?

Application. As a result of these experiments on breathing and ventilation, the children should be led to see the need of ventilation and the method by which it can be secured under all conditions. Special emphasis should be placed on the ventilation of the schoolroom and of the sleeping-room at night by the children.

II. Heating the Home and the Schoolroom

A. Sources of heat

Apparatus: Stick of wood, board with groove, file, nail, penny, hammer, stone, sulphuric acid, unslaked lime, lime water, a burning-glass.

1. Friction. Rub a stick back and forth in a groove of wood; feel of the wood. Rub a coin over the table; feel of the coin. File a nail vigorously, and then feel of the nail.

2. Percussion. Place a penny or a piece of metal on a stone and strike it several times with a hammer; feel the metal.

3. Chemical action. Pour a few drops of sulphuric acid into a small dish of water; notice the change in temperature by feeling of the outside of the dish. Or add some water to unslaked lime and note the results.

4. Electricity. Turn on the electric light and hold the hand over the bulb. What do you notice?

5. Combustion. Light a splint of wood and insert it in a wide-mouthed bottle. When it goes out, light it and insert in the

bottle again. Pour some lime water into the bottle, cover with a piece of cardboard, and shake. What change takes place in the lime water? This white precipitate shows the presence of carbon dioxide formed by the burning of wood.

6. The Sun. Hold a burning-glass at right angles to the sun's rays and focus on a piece of paper.

B. Method of starting fires

Notice the parts of an ordinary match. Light it and note the order in which the different parts burn. Compare a safety match with an ordinary match and note the differences. Try to light each one on an ordinary board surface. What difference do you find? What advantage has the safety match?

C. Effect of heat

1. On gases.

Apparatus: Flask, rubber stopper with a single hole, glass tubing, alcohol lamp, tumbler, chimney, joss stick or cloth, candle.

Push the tubing through the stopper and insert the stopper in the flask. Fill the tumbler with water and place the end of the tube in it, and heat the flask gently with the alcohol lamp. Notice what happens at the end of the tube. What is the explanation? Remove the lamp, but allow the end of the tube to remain in the water. What happens? What does this show?

Light a candle. On each side place a match. On the matches place a chimney. Light a joss stick or piece of cloth and hold at the lower end of the chimney near the matches. What do you notice inside of the chimney? What does this show?

How are the principles shown in these two experiments applied in the hot-air furnace?

2. On liquids.

Apparatus: Flask, stopper, and tube as in previous experiment, test tube, sawdust.

Fill the flask with water and insert the stopper so that the water stands in the tube about an inch above the stopper. Tie a colored string around the tube at the surface of the water. Heat the flask with the alcohol lamp and watch the liquid in the tube. Remove the lamp and allow the water to cool. What happens to the water in the tube in each case? What does this show? Put some sawdust in a test tube filled with water, and heat. Note the motion of the sawdust.

How are the principles illustrated by these two experiments applied in hot-water heating?

D. Measuring the temperature

1. How to use a thermometer.

Apparatus: Ordinary thermometer, card thermometer, ice, warm water.

The children in the third grade may each make a cardboard thermometer. Get a piece of cardboard about an inch and a half wide and a little longer than an ordinary thermometer. Draw a line through the center of the cardboard and copy on it the readings of the thermometer scale, ranging from 20° below zero to 100° above. Punch a hole through the cardboard at each of these ends of the scale. Pass through one hole a white string and through the other hole a red or blue string. Tie them together at the back of the cardboard. Pull them tight and tie them in front. In place of a string a narrow ribbon may be used.

The colored string represents the liquid in a thermometer, and the knot represents the top of the liquid. Set this knot at various positions and ask the children to read them. Ask the children to set their thermometers at various temperatures.

After the children can read these, use the ordinary thermometer and have them read it at various temperatures. Breathe on the bulb, place the bulb in ice water, then add warm water, and have a reading made each time.

Have the children make readings of the thermometer for a week both indoors and out of doors at different times of the day, and keep records on the board.

III. Foods

A. To test foods for nutrients

Apparatus: Various kinds of food, iodine, nitric acid, ammonia, alcohol lamp.

1. To test for starch.

Heat a little starch in water, allow it to cool, and then add a few drops of a diluted solution of iodine in alcohol. A blue color shows the presence of starch. Test in a similar way a number of common foods.

2. To test for proteins.

Heat the white of an egg slowly. This hardening is a test for proteins.

For another test add some nitric acid to a piece of meat, and boil. Pour out the acid, rinse the meat in water, and then add ammonia. The yellow color is a test for proteins. Test a number of foods for protein.

3. To test for fats.

Place a piece of butter on a bit of paper and warm gently. What change takes place in the paper? This is a test for fat.

For another test heat the substance gently in a test tube without burning the food. Then add warm water and see if any fat collects on the surface.

Test a number of foods for fats.

Put records in the form of the following tables: —

Kind of food	*Starch*	*Protein*	*Fat*

Put the names of the foods in the first column, and put a check opposite each food in the proper column to correspond with the tests.

B. To study the action of baking powders

Put a little baking powder into water and note what happens. Put some powder into vinegar and note the results.

Dissolve soda and cream of tartar separately in cold water. Then pour one into the other. Try hot water and note any difference.

C. To study the action of yeast

Make a paste of flour and water. Mix with this a small piece of yeast cake. Allow to stand a while in a warm place and notice what happens.

Put in each of two test tubes or small bottles a teaspoonful of molasses and ten teaspoonfuls of water. Mix a small piece of yeast cake with water and add half to each bottle. Allow to stand

for a day, one in a cool place, such as an ice chest, and the other in a warm place. Notice any difference in the two at the end of that time.

IV. The Eye

Materials: Snellen's vision chart, piece of white cardboard about six inches square, reading-lens, convex and concave lenses, candle.

1. To test the eye.

The teacher should secure a Snellen's vision chart, and following the directions there given should test the eyes of each child. Cases of defective vision should be reported to the principal.

2. To show how the image is formed.

Hold the reading-glass and the white cardboard in line with the window till images appear distinct on the cardboard. How does the image differ from the object? How does the distance affect the relative size of the image?

3. To illustrate binocular vision.

a. Hold two pencils vertically before the eye, one about a foot away and the other about two feet. Look at the nearer pencil with both eyes. How does the other pencil appear? Look at the farther pencil with both eyes. How does the nearer pencil appear?

b. Shut one eye. Hold a pencil in each hand about a foot from the eye and try to bring the points together. Try it with both eyes open.

4. To show the existence of the blind spot in the eye.

On a piece of paper make a cross and circle about as far apart as the two eyes.

Hold the circle in front of the right eye. Close the left eye. Look steadily at the cross and move the paper back and forth till the circle disappears.

PART V
PHYSICAL SCIENCE

CHAPTER XVI

PHYSICS AND CHEMISTRY

The practical applications of physics and chemistry play such an important part in the child's life that some study of these should be made in the science course. The method of teaching biological science is largely through observation; the method of teaching physical science is largely through experimentation. In preparing this chapter the author has considered the applications of physics and chemistry in the child's life. In order to illustrate the uses of these applications and the principles involved, he has sought to suggest a series of simple experiments that can be performed in the schoolroom with such apparatus as can easily be secured by the teacher and children.

When the science work in the grades has become better organized and its value better understood, apparatus will be supplied by the school authorities, as is now done for geography and other subjects. Very likely this matter will be solved through the extension of the junior high school, which permits of departmental teaching and will be furnished apparatus similar to that now supplied high schools. At the present time, however, little apparatus is furnished for the science work in the grades, and hence the need of suggesting experiments that may be performed with the simplest outfit.

The work outlined in this chapter is adapted to the grammar and upper intermediate grades.

I. Lighting Our Homes

A. Parts of candle flame

Apparatus: Candle, piece of glass or cardboard.

1. Light the candle. After it is burning well, light a match, blow out the candle, and then hold the lighted match about a half-inch above the candle. Why does it light? Try several times to see how far above the candle you can hold the match and have it light.

2. How many parts do you see in the candle flame? What is happening to the paraffin near the wick? Blow out the candle flame. Look quickly at the wick and feel of it. What does it contain?

3. Press a piece of glass or cardboard down on the flame and hold for a second or two. What is formed on the glass? How is it arranged?

Hold the phosphorus of a match in the central cone of the candle. Does it burn quickly?

Hold a match or toothpick right across the middle of the flame till it begins to burn. Then take it away and blow out the flame on the wood quickly. Where did it begin to burn first?

What do the experiments so far performed show about the structure of the candle flame?

B. Conditions needed for candle to burn

Apparatus: Lamp chimney with level top, lime water, glass tumbler.

1. Light the candle. Invert a glass tumbler over it. Why does it go out? Light the candle again. Invert over it a canning-jar. Does the candle burn any longer? Why?

2. Light the candle. On each side place a match and on these put the lamp chimney. Does the flame act any differently?

3. Place a piece of cardboard on the top of the chimney. Why does the flame go out?

4. Light the candle and place it on a piece of blotting-paper. Put the chimney over the candle and hold it down firmly on the paper. Why does the flame go out now?

What do these experiments show that a candle needs in order to burn?

5. In order to show what is given off when a candle burns, place a candle about an inch long in a glass tumbler. Light it, and cover with a piece of cardboard. After the flame goes out, quickly re-

move the candle and pour in some lime water. Cover the tumbler and shake. The white substance formed shows the presence of carbon dioxide.

C. Gas and electric meters

Have the children read both a gas meter and an electric meter, either in the school building or at home. Have them note which way the hands on the dials turn. Have a drawing made of the dials and the hands showing the reading. At the end of the week have another reading and drawing made. From this have them compute how much the cost for a week was of both the gas and electricity.

Have them notice how the gas and electricity can be turned off from the meter.

II. Water

A. Some properties of water

Materials: Small vial and stopper, penny, tumbler.

1. To make a carpenter's level.

Fill a vial nearly full of water and cork it. Place it on its side. Add enough water so that an air bubble about a half-inch long is left. Try this on various surfaces, such as desks and tables, and see if they are level. Test by comparison with a regular carpenter's level. What property of water does this experiment show?

2. Gases in water.

Draw some fresh water from a faucet in a bottle and allow to stand for several hours or a day. What collects on the side? Does this have any relation to the fact that fishes can live in water?

3. Effect of water in bending light.

Put a penny in the bottom of a tumbler. Stand in such a position that the edge of the penny is just in line with the rim of the tumbler. Pour water into the tumbler and note the change in the apparent position of the penny.

B. Changes of water from one state to another

Materials: Tumblers, thermometer, flask, alcohol lamp, tin cup, bottle, salt, can with small opening.

1. Evaporation.

a. Fill a tumbler half full of water. Pour the same amount of water into a plate. Allow both to stand side by side for several days. From which does the water evaporate more quickly? Why?

b. Fill two tumblers half full of water. Place one in the warmest part of the room. Put the other in a cool place out of doors if the weather is not freezing. Which evaporates faster? Why?

c. Fill two tumblers half full of water. Put them in a place where the wind blows across them. Cover one with a dish. Allow to stand. Which evaporates faster? Why?

d. Fasten a piece of cloth around the bulb of a thermometer. Note the reading. Wet the cloth and fan for a minute or two. Read the thermometer again. What change has taken place? What does this show? What applications of this principle have you observed?

e. Making water boil with ice. Fill a flask about one fourth full of water and heat till it boils. Remove the flask and cork tightly at once. Invert the flask and pour over it water containing ice or snow. Why does the water begin to boil again?

2. Condensation.

Heat some water till it boils. Hold a cold surface above the flask. What collects on it? Why?

Fill a bright tin cup about half full of water. Add snow or ice mixed with salt to the water. Watch the outside of the dish. What collects there? Why?

C. Freezing and melting

1. Temperature.

Put some ice in a tumbler of water. Place a thermometer in this, stirring the water. What is the lowest temperature to which it falls?

2. Expansion in freezing.

Fill a glass bottle with water and insert a cork tightly. Secure a varnish can, or a molasses or syrup can with a small opening. Fill it completely with water. Put the bottle and can out of doors where the water will freeze. Examine the next day and see what has happened. Examine the crystals of ice.

Put a rectangular piece of ice in water. Why does it float? Measure the part that is above water and the part that is below. What fraction of the whole is above water?

What two changes take place in freezing as shown by these experiments?

3. Making ice cream.

Put a mixture of salt and crushed ice in a tumbler, put in a thermometer and record the temperature. Try different proportions of ice and salt and find which gives the lowest temperature.

Put a test tube containing water into the mixture of ice and salt.

Fill a tin cup with snow or ice. Place the cup on a board covered with water. Stir some salt into the snow or ice. What happens to the water on the board and the bottom of the cup? Why?

D. Pumping water

When water is pumped, it is forced up through the pipe by the weight of the air pressing on the surface of the water. This pressure of the air may be shown by a number of simple experiments.

Materials: Rubber tubing, or glass tube bent at an acute angle, medicine dropper, test tube, glass tubing about eight inches long, tumbler, pint milk bottle, hard-boiled egg with shell removed.

1. Secure a piece of rubber tubing about a foot and a half long. Submerge this in a dish of water till the tube is full of water. Pinch one end of the tube and bring it out over the edge of the dish and place it over an empty dish set a little lower than the first dish. What makes the water flow? Raise the second dish higher than the first and notice what happens. A piece of bent glass tubing may be used in place of the rubber tube. This is called a siphon.

2. Squeeze the bulb on a medicine dropper and put the end in water. Remove the pressure from the bulb. Why does the water enter the dropper?

3. Fill a test tube with water. Place your thumb over the end and invert it in a dish of water removing the thumb after the end of the tube is under water. Why does the water stay in the tube?

4. Put a piece of glass tubing in water. Place the finger over the upper end and remove from the water. Why does the water stay in the tube? Remove the finger. Why does the water fall? Why is it possible to drink soda through a straw?

5. Fill a tumbler full of water. Over the top place a piece of paper and press it down firmly on the rim. Hold the paper on with one hand and invert the tumbler with the other. Remove the hand from the paper. What keeps the paper up?

6. Light a piece of paper and drop it into a pint milk bottle.

After the flame goes out, put a hard-boiled egg with the shell removed, in the mouth of the bottle. What forces the egg into the bottle?

F. Reading the water meter

Have the children read the water meter, either in the school building or at home. Have a drawing made showing dial and position of hands. Have it read again at the end of the week. Compute how much water was used, and how much it cost for a day or week.

III. Means of travel

A. The locomotive

Usually some boy in the class has a toy steam engine. Ask him to bring it to school. Set the engine going and notice what happens in the various parts. Help the children to understand the principles involved.

B. The trolley

The trolley is propelled by the motor, and the electro-magnet is an important part of a motor, so that in order to understand how the motor works we will first study the action of the magnet.

1. The Magnet.

Apparatus: Two bar magnets, horseshoe magnet, pieces of metals, such as iron, steel, tin, zinc, a dime, a copper, a nickel, sheets of iron, tin, and zinc, piece of glass, cardboard, thin piece of board, such as cover of chalk box, iron filings, darning needle.

a. Magnetic substances. Take a magnet and try a great many substances to see which it will attract. Find the greatest distance that a piece of iron is attracted. Put the end of the magnet in a box of tacks. Try various portions of the magnet and see which is the strongest part. Put the magnet in iron filings.

Test needles, pins, pens, etc., to see if they are made of iron or steel.

b. Action of magnetism through various substances. Place sheets of various kinds of substances such as glass, paper, wood, iron, tin, zinc, etc., over a pile of tacks, and hold the magnet over the sheet and see if the tacks are attracted. Determine through which substances the magnetism does not act.

c. Action of magnets toward each other. (In case a bar magnet cannot be obtained, one may be made from a knitting-needle, if a horseshoe magnet is on hand, as explained later under *e.*) Make a stirrup of a piece of wire and suspend a bar magnet or a magnetized knitting-needle in this by means of a string. Bring the north pole of the other magnet near the north pole of the suspended magnet. Bring it near the south pole. What difference do you note? Try various combinations till you can tell the law that the magnets follow.

d. The magnetic field.

(1) Place a bar magnet on the table and put over it a sheet of paper. Sprinkle iron filings over this paper. Make a drawing showing the way the filings arrange themselves. Put two like poles of two bar magnets about an inch apart and sprinkle the iron filings. Draw. Do the same with two unlike poles. Draw. What is the difference in the arrangement of the filings? Place a horseshoe magnet under the paper and sprinkle the filings.

(2) *To make blue prints of the magnetic field.* Repeat the previous experiments, only, instead of the ordinary paper, use a piece of blue-print paper over the magnets. Place in a shaded part of the room and sprinkle filings on the paper. Carefully place a piece of glass on the filings and put the magnet and all in the sunlight and allow to stand till the paper becomes bronze. This will take from five to twenty minutes, according to the light. Then shake off the filings and wash the paper in several changes of water and then dry.

e. How to make magnets. Rub one end of a needle on one end of a magnet, rubbing several times in the same direction. Then rub the other end of the needle on the other end of the magnet. See if the needle will pick up tacks. The blade of a jack-knife may be magnetized by rubbing over a magnet. Try bringing another needle near a pole of a magnet, but not quite touching it. See if the needle becomes magnetized.

Break a magnetized needle in two. Test each end of both pieces to see if they are magnetic, and if each piece has both a north and a south pole.

2. The electro-magnet.

Apparatus: Large nail or bolt about six inches long, about twenty feet of insulated wire, dry cell, tacks, magnet.

a. An electro-magnet is an important part of a motor. It can

be made as follows: Wind about ten feet of insulated wire around a large nail or bolt, as thread is wound on a spool. Place the end of the nail in a pile of tacks. Is it a magnet? Connect the wire with a dry cell. Is it a magnet now? Withdraw the nail and see whether the coil will pick up fewer or more tacks. Disconnect the cells. What happens? Connect the cells again. See if a needle can be magnetized by rubbing against the nail.

b. Test the electro-magnet by bringing it near the end of a suspended magnet or compass to see if it has a north and south pole. Change the connection of the cell so that the current passes through the wire in the opposite direction. Test again for the north and south pole. What difference do you find?

c. Wind five feet of wire around the nail and see how the number of tacks it lifts compares with the number when ten feet of wire were used. Try twenty feet and note the difference. Try two cells and compare the number of tacks lifted when one cell is used with the same length of wire. In what ways do these experiments show that the strength of an electro-magnet may be increased?

3. Toy motor.

Usually some boy in the class has a toy motor that he will be glad to bring to school. Notice the structure of the motor. Connect with a cell and notice how the motor works. Help the children to an explanation of the principles involved.

C. The boat

1. How a boat floats.

Apparatus: Spring balance, stone, block of wood, small plate, shot, egg, salt, funnel.

a. To show the buoyant effect of water on a sinking body, weigh a stone on a spring balance. Then weigh it while suspended in water. How much has it lost? To what is this loss due?

b. To show the buoyant effect on a floating body, fill a small pail as full of water as possible. Set it in a plate. Weigh a block of wood. Place it on the surface of water in the pail, catching the overflow in the plate. Find how much the water in the plate weighs. How does the weight of the block of wood compare with the weight of the water it displaced? Try several pieces of wood.

Put some shot in a test tube and float the tube in a dish of water. Glass and shot are both heavier than water. Why, then, does the tube float? Ships are made of steel which is heavier than water.

Why do steel boats float? Add more shot to the tube. What happens? Remove some shot. What happens? Why? What fact does this illustrate about the loading and unloading of a boat?

c. To show the difference between the buoyancy of fresh and salt water, put an egg into a dish filled with fresh water. What happens? Put an egg into a strong solution of salt and water. What happens? What makes the difference?

2. How the boat is propelled.

Apparatus: flask, rubber stopper with one hole, glass tube, toy windmill.

a. Steamboats are run by the steam engine. The following simple experiment illustrates the principle of a kind of steam engine, called the steam turbine, that is now being commonly used on steamships.

b. To make a toy windmill, take a square piece of paper and cut from each corner inward nearly to the center. Fold over every other point. Pass a pin through the four points and through the center of the paper and then into a wooden handle.

c. Insert in the flask a rubber stopper with a hole through which has been passed a short piece of small glass tubing drawn nearly to a point so as to leave only a small opening. Heat the flask until the water boils vigorously. Then hold the windmill over the glass tubing where the steam is escaping. What makes the wheel revolve?

3. How the boat is guided.

Apparatus: Compass, magnet, two darning-needles, cork, knitting-needle, cell, toy gyroscope.

a. The compass. Note in what direction the needle of the compass points. Bring the north end of a magnet near the north pole of the compass. Then bring it near the south pole. What is the difference in the action?

Connect the two posts of a cell with a wire. Hold this wire in a north-and-south direction over the compass and note result. Turn the wire around and hold it over the needle. What difference do you notice?

Magnetize a knitting-needle as explained in a previous experiment (page 175). Fold a piece of paper about an inch square diagonally. Place the needle in the crease of paper and suspend the paper by means of a thread. In what position does the needle come to rest? Move it and try several times. Does it always come to the same position?

Magnetize a large darning-needle by rubbing the point on the north end of a magnet, and the eye on the south pole. Magnetize another needle by rubbing the point on the south pole of the magnet and the eye on the north pole. Cut two thin pieces of cork from a stopper and float the needles on these pieces. In what position do they come to rest? Do the points of both needles point in the same direction? Can you explain?

b. The gyroscope. Follow the instructions that come with the gyroscope. What is the peculiarity of this toy? A gyroscope is often used instead of a compass to guide ships. Can you see how it could be used for this purpose?

4. How the submarine sinks and rises.

Put the stopper in a bottle and place the bottle in water. Why does it float? Fill the bottle with water. Put in the stopper and place the bottle in water. Why does it sink? Remove the bottle and pour out the water. Insert the stopper and push the bottle down to the bottom of the dish and then let go of the bottle. What happens? Why? How could this same principle be used in making a submarine sink and rise?

IV. Taking Pictures

A. Pin-hole camera

To make a pin-hole camera, secure a small pasteboard box about two inches deep. Cut a hole about an inch square in the cover and fasten over this a piece of white tissue paper. In the middle of the side opposite make a pin-hole. Point this hole toward a lighted candle and cover the head and box with a cloth or jacket. What do you see on the tissue paper? What is the position of the image? How does the size of the image change as the camera is brought nearer the object or taken farther away?

Hold a reading-lens about three feet from the candle and place a white piece of paper behind the lens till a clear image of the candle is formed. What improvement has the lens made in the image over the one formed by the pin-hole camera?

B. The ordinary camera

1. A focusing kodak can usually be obtained from some member of the class and brought to school. One lesson may be given on the structure of the kodak and the method of making exposures.

2. If a developing tank can be obtained from some member of the class for a second lesson, the method of developing films in this tank may be shown by actually developing a film.

3. For a third lesson methods of printing may be shown. Two types of paper may be illustrated, the developing, like velox, and the printing, like blue print. Prints from blue print can be made in the schoolroom during the daytime, and they are very easily treated because it is only necessary to put them in cold water and then dry them. The blue print may also be used to make outlines of objects, such as leaves, ferns, laces, and other thin articles.

V. Methods of Telling Time

A. The hour-glass

Procure two small bottles of the same size, each provided with stoppers. Make a hole in the center of each stopper, and push through it a piece of glass tubing twice as long as the thickness of the stopper, so that both stoppers shall be on the same tubing, one at each end. Fill one bottle with fine sand. Insert the stopper. Place the other bottle on the other stopper. Invert the bottles. How long does it take for all the sand to fall through? Change the amount until it passes through in a definite time, such as two or five minutes.

B. The pendulum clock

1. Suspend a small pail by means of a string. Set in motion and count the number of vibrations it makes in a minute. Put about an inch of sand or any small heavy objects in the pail, and see if the weight makes any difference in the number of vibrations.

2. Suspend a stone from a string about a yard long. Start it to vibrating through a small arc and count the number of swings it makes in a minute. Set it to vibrating through a long arc and see whether the number of vibrations in a minute changes.

3. Make the string about half as long and see how the number of vibrations is affected. Make it longer than the first and note the change in the number of vibrations. If a pendulum clock gains time, what should be done to the pendulum? What if it loses?

4. Change the length of the string until it beats just once in a second. How long is it? What else besides a pendulum is needed to make a clock? What purpose does a pendulum serve in a clock?

5. What effect does each of the following factors have on the time of vibration of a pendulum: weight, length, and distance through which the pendulum swings?

VI. Some Simple Machines that make Man's Work easier

A. The lever

Apparatus: Yardstick, triangular block of wood, jack-knife, hammer, scissors, nut-cracker, can-opener.

1. Place the center of the yardstick over the edge of the prism, which is called the fulcrum. On each end place books of equal weights at equal distances What happens? On one end place two books and move the prism till the stick balances. Where is the prism situated? If the power be placed at the end of the long arm and the weight to be lifted at the end of the short arm, what advantage does the lever have? If the power and weight are reversed, what advantage does the lever then have?

2. Put the prism at the middle of the stick. Place weights on the stick at different distances till the stick balances. Try a number of combinations and find the relation that exists between the two weights and the length of the arms measured from the fulcrum to the center of the weights. When using a teeter, how do children apply the principles brought out by these experiments?

3. Use a hammer to draw a nail, open the blade of a jack-knife, cut some paper with a pair of scissors, crack a nut with a nut-cracker, open a can with a can-opener. In each case explain how it is an application of the lever by pointing out the fulcrum, the power, and the weight. Find as many other applications of the lever as you can.

B. Inclined plane

Apparatus: Smooth board about two feet long, spring balance, a small toy cart.

1. Place one end of the board on a pile of books. Weigh the cart. Pull it up the board by means of the spring balance. How does the force required compare with the weight of the cart?

2. Put weights in the cart and perform the experiment again.

3. Vary the height of the board and see how the power necessary to pull up the cart varies with the height.

4. What advantage do these experiments show that the inclined plane has? What applications of the inclined plane can you find?

C. The screw

Apparatus: Screw, screwdriver, carpenter's brace, and screwdriver bit, vise.

1. Measure the length of a screw, and divide this by the number of threads in order to get the distance between two threads. How far must the hand turn in using a screwdriver to turn in the screw one thread? In using the carpenter's brace how far must the hand move?

2. Measure the distance between two threads of a vise. How far does the hand move in advancing the vise one thread? This distance divided by the distance between two threads gives the number of times the force applied at the handle is multiplied.

3. What advantage has the screw? Find as many applications of the screw as you can.

4. Look carefully at the following machines, and write down all the simple machines you find in each: a sewing machine, a washing machine, a bicycle, a typewriter, and a clothes wringer.

VII. Evening Entertainments

A. The violin and piano

Apparatus: Box about two feet long, banjo or violin strings of different materials and different sizes, three bricks.

1. Secure a box about two feet long with the cover removed. In the board at one end drive three nails, about an inch apart. To two of these nails fasten strings made of the same material, but of different size. To the third fasten a string made of different material, but of the same size as one of the others.

2. At the other end of the box cut three notches opposite the three nails. Pass the strings across these notches and fasten a brick to the end of each. Strike a large string and then a small string, both of the same material, with the finger. What is the difference in pitch? Strike a string of gut and then one of metal of the same size and note the difference in pitch.

3. To one string fasten two bricks and strike it with the finger. How does its pitch compare with that when only one brick was attached?

4. Halfway down the length of the box place a stick across the box under the strings. Hold one string securely against this stick

and strike the string with the finger. How does the pitch now compare with that when the string was twice as long?

5. These experiments show that pitch depends on what four factors? Which of these factors are used in determining the pitch of the notes on each of the following instruments: the piano, banjo, mandolin, and guitar? If you do not recall how all of these are made, look them up and report to the class.

B. The movies

Apparatus: Toy magic lantern, cardboard about six inches square, string.

1. The moving-picture machine.

The moving-picture machine is a stereopticon so arranged that the pictures are shown rapidly, about sixteen per second. If possible, obtain from some child a toy magic lantern. Have the children notice the structure of the various parts. Darken the room by pulling down the curtains and show how the machine works.

2. To learn why we seem to see a continuous set of pictures at the movies.

Cut out a round piece of cardboard about six inches in diameter. A half-inch on each side of the center punch a hole with the point of a pencil. Through these holes pass a string about four feet long. Tie the ends, thus making a loop about a foot long on each side. Hold a string at the center with a pin, and with a radius of two inches draw four separate arcs of a circle, about half an inch long and equally spaced. These lines represent the pictures thrown on the screen, and the blank spaces between represent the intervening time when the screen is darkened.

Hold the loop on each side by the thumbs and have some one turn the cardboard till the string is twisted. Then pull gently on the strings with the thumbs, thus making the cardboard revolve. Watch the side with the arcs on it and note what one sees. How do you explain the fact that these four lines seem to make a continuous circle? Erase two opposite lines and then rotate the card. Then erase one of the remaining two and try again. Try a line near the center and one out near the circumference of the cardboard, and see if it makes any difference. Try rotating the disc fast and then slow, and note the difference. What determines whether the dashes seem to make a continuous circle or not?

In the movies about sixteen pictures per second are thrown on the screen, each remaining about one thirty-second of a second, and between the pictures the screen is darkened for about the same length of time, so that the screen is darkened and has no pictures on it for about one half of the time. How does this experiment help illustrate what we see at the movies?

VIII. Chemistry of the Kitchen

A. Acids, bases, and salts

Materials: Red and blue litmus paper, vinegar, ammonia, lime water, lemon.

1. Pour a little vinegar into a dish. Place in it a small strip of blue litmus paper. This is the test for an acid.

2. Pour a little ammonia into a dish. Place in it a small strip of red litmus paper. This is the test for a base.

3. Dissolve some salt or sugar in water. Put in this a piece of red litmus and also one of blue litmus. Does any change take place? This is said to be a neutral solution.

4. Get as many common substances as you can from the kitchen, such as lemon, orange, lime water, sugar, sour milk, sweet milk, buttermilk, baking soda, cream of tartar, baking powder, tomatoes, apple, any fresh fruit, tea, coffee, washing soda, wood ashes. Test each one of these with both red and blue litmus paper. Test the juices of the fruits. Dissolve the powders in water. Pour water on the ashes and then filter. Steep the tea and coffee in water. Place the name of each substance in the proper place under the following headings: —

Acid	*Base*	*Neutral*

B. Hard and soft water

Materials: soap, test tube, alcohol lamp.

1. Make a soap solution by heating a little soap in soft water in a test tube. Take a little hard water and add to it a measured quan-

tity of soap solution. Note the results. Take the same quantity of soft water and add the same quantity of soap solution as in the previous experiment. What difference do you notice?

2. Add more soap solution to the first test tube and see if it is possible to get a good lather by adding enough soap.

3. Boil some hard water for several minutes. Then add the same amount of soap solution to the same amount of water as in the first experiment and see if any better suds are formed. If boiling removes the hardness, it is called temporary.

CHAPTER XVII

WEATHER AND SKY STUDIES

I. Weather studies

Weather observations. Many instructive studies can be carried on in connection with the weather. One of the first things to do is to have the children make observations on the weather and have records kept in the schoolroom. These may well be carried on for a month in the autumn, a month in the winter, and a month in the spring.

For the primary grades a pictorial record may be kept on the blackboard or on a large piece of cardboard. On this should be copied, much enlarged, the calendar for the month, showing the days of the week and the number of the days in the month. Squares or circles of gummed colored paper may be taken to represent the kinds of weather, a certain color for each kind of weather. The following colors are suggested for the kinds of days: yellow for sunny, black for cloudy, white for snowy, green for rainy, and red for windy.

For the intermediate grades more definite records may be kept, as suggested in the following table: —

Date	*Temperature*	*Sky*	*Wind*	*Precipitation*	
				Kind	*Amount*

Under *temperature* may be recorded whether hot, warm, cold, or very cold; under *sky*, whether clear or cloudy; under *wind*, the velocity, whether calm, light, or heavy; under *kind of precipitation*, whether rain or snow; under *amount*, whether light or heavy.

In the grammar grades more accurate records may be made by the use of instruments — the thermometer, weather vane, and barometer.

Weather charts for primary grades. A great variety of charts may be made by primary children. Following are suggested some topics for these charts: —

Autumn Work and Play.
Getting Ready for Winter.
Signs of Spring.
Signs of Winter.
Work which Snow Makes.
Work which Snow Helps.
Fun which the Snow Brings.

Pictures illustrating these topics may be cut out by the children and pasted on a piece of cardboard.

Study of weather maps. In the grammar grades a study of weather maps may be made. These may be obtained free by writing to the nearest weather station in the State where maps are published, and explaining the purpose for which they are intended.

The children should first study the various features of the map so that they may understand what they mean, the isotherms, isobars, arrows, etc. The weather conditions accompanying the low and high areas should be noted. By studying maps for several successive days the direction in which the areas move and their velocity may be determined. Finally, some of the principles involved in weather forecasting may be brought out, and the children may try to forecast the weather for the next day from the maps.

To find the dew point. The following experiment may be performed in the grammar grades. Secure a tin cup with brightly polished surface on the outside. In this put some snow or crushed ice mixed with salt, and stir with a thermometer. Watch the outside of the dish and when the first dew appears, take the reading of the thermometer. Pour warm water in the dish, stir, and when the dew disappears, read the thermometer. The average of these two readings is the dew point for the room. If all the air in the room were to be lowered to this temperature, what would happen?

II. Sky studies

The heavenly bodies are the most common and important factors in the child's life. In the study of science we may lead the children to make observations on their changes and may teach them some of the more interesting facts about them.

To measure the length of the sun's shadow. To find the length of the sun's shadow at noon, a shadow stick may be made by driving a nail into one end of a board. The length of the nail and board should be so adjusted that the shadow of the nail falls on the board. Straight back from the nail mark off distances in inches, halves, quarters, and eighths, so that the length of the shadow may be read at a glance. Place the board so that the long axis points north and south. At noon measure the length of the shadow, or else make a mark on the board and write the date opposite. These readings should be made about once a week, and on a certain day. Once a month have the position of the end of the shadow marked every hour from 9 A.M. till 4 P.M. Connect these dots with a line. How do these curves compare from month to month? Instead of marking on the board, a piece of paper may be laid on the board and the marks and curves made on this.

Have the readings of the length of shadow put in the form of a table on the blackboard or on a piece of cardboard. At the end of the series of observations have the significance of the changes discussed.

Observations on the moon. Let the primary children make a moon chart, similar to that for the weather suggested on page 185. Make a calendar for a month on a piece of cardboard. Beginning with the new moon have the children report every few days on the shape of the moon. Let them cut out a piece of yellow paper to represent the shape of the moon as they see it, and paste this on the calendar in the proper place. Have this kept for a month.

For the children in the intermediate and grammar grades, more careful and complete records may be kept in the form of the following table, which may be kept on the board or on a piece of paper: —

Phase (*shape*)	*Time of setting or rising*	*Place of setting or rising*

The record of the place of rising and setting may be made in terms of the points of the compass. Have the observations begin at the time of the new moon and continue for a month. Reports should be made twice a week. At each report have a drawing made showing the shape of the moon. Have these drawings made side by side on the same piece of paper, so that by the end of the month the child will have drawings of about eight phases.

Have the children note the position of the moon in the sky with reference to some group of stars, and see if it keeps the same position. How much does it change in a week?

In order to make clear the phases of the moon, color one half of a ball yellow with crayon to represent the lighted portion of the moon, and the other half black to represent the part in shadow. Hold the ball in different positions so as to represent the different phases of the moon.

The stars: constellations. In connection with the study of stars the children may be taught to recognize the more conspicuous constellations. The best way, if it is possible, is to go out with the children some evening. But in place of this the observations of the children may be directed by the teacher in the schoolroom.

The first step is to have the children find the Great Dipper and the North Star. Then take up the circumpolar constellations that never set in this latitude; the Little Dipper, Cassiopeia's Chair, the Dragon, and Cepheus. The remaining stars may be taken up in three groups; the early autumn stars, the winter stars, and the late spring stars, each at the appropriate time.

In preparation for the study of a certain constellation, the teacher should place on the board a diagram showing the position of the stars in the constellation, and should explain how to find them with reference to other stars that the children already know. After opportunity has been given for the children to make observations, the reports should be made and discussed in class. Detailed suggestions on how to take up the study of the different constellations are given in Comstock's *Handbook of Nature-Study*.

Interesting facts about the heavenly bodies. In connection with these observations on the heavenly bodies, the teacher should explain to the children some of the more interesting facts about them. An attempt may first be made to give the children some conception of the solar system as a whole. In order to do this, diagrams should be drawn on the board. Circles may be drawn, of the correct propor-

tionate size, to show the relative sizes of sun, moon, earth, and other planets. Starting with a dot to represent the sun, other dots may be placed on the board to represent approximately the relative distances of the various planets from the sun.

The relative sizes could be illustrated by making balls out of clay or putty, or by blowing up toy balloons to various sizes. The diameter of the sun is approximately one hundred times as great as that of the earth. If a balloon is blown up to a size of one foot to represent the sun, then a ball of putty one eighth of an inch in diameter would represent the earth, and another ball one thirty-second of an inch (about one half as large as the head of a pin) would represent the moon. The sizes of the other planets could be shown by balls of clay or putty.

In the winter-time snowballs could be made out of doors to represent the sizes of the various heavenly bodies. If a snowball a half-inch through represents the earth, a ball four feet through would represent the sun, and one an eighth of an inch through, the moon.

PART VI
OUTLINE OF SCIENCE INSTRUCTION

CHAPTER XVIII

BASIS FOR ORGANIZATION OF OUTLINE OF SCIENCE

General principles. There are certain principles which must underlie all teaching, and these principles must apply to science teaching. Still further, there are certain principles which must underlie all science teaching, whether in Maine or in California. The particular topics taught must vary according to the locality, but the underlying principles must be the same.

In times past, there have been those who advised that there should be no organized course in science, but that there should be a miscellaneous study of whatever materials happened to be found by the teacher or children. The need of a well-organized course assigning definite topics to certain grades is now so well recognized that it will not be necessary to discuss it further.

Basis for organization. The basis for the organization of this outline has been sought in the child's life rather than in the subject-matter; and in the interests and needs of the child's present life and immediate future, rather than in the interests and needs of the distant and indefinite future. In thus stressing the present, the future is not overlooked, for the fulfillment of the child's present needs is the best possible preparation for the fulfillment of his future needs when these may arise.

The purpose has been to make the outline psychologically and pedagogically logical from the child's standpoint, rather than technically and systematically logical from the scientist's standpoint.

The general principle, governing in the selection of topics

for this outline may be briefly stated as follows: any topic is worthy of a place in direct proportion to the number and value of the elements which it possesses in common with the child's life.

Four points of view. The selection and arrangement of topics in the outline may be considered from four standpoints: (1) the general aims of nature-study; (2) the phases of nature-study included; (3) the seasons of the year; (4) the age of the child.

The arrangement of topics from the standpoint of aims and phases has been discussed in previous chapters, and is shown diagrammatically in figures 1 and 2.

The seasons. The natural activities of the seasons have been followed, the various plants and animals being studied when they are most in evidence. This puts the agricultural and biological phases in the autumn and spring, leaving the physical, astronomical, and hygienic phases to be taken up during the winter. In the autumn special attention is given to late flowers, trees, and insects; and in the spring to spring flowers, birds, and gardening.

In the study of trees, the same species is studied through one grade in the autumn, winter, and spring, thus showing the different aspects of tree activities.

In the autumn certain groups of cultivated flowers and vegetables are studied. In the following spring the seeds of these same flowers and vegetables are suggested for planting. In the autumn some bulbs are studied and planted both indoors and out of doors. In the winter and spring the flowers which develop from these bulbs are studied.

Such a large proportion of the school year comes during the cold months that special plans should be made to improve the opportunity offered during the first half of the fall term and the last half of the spring term to study plants and animals in their outdoor activities. In order that the greatest

advantage may be taken of these seasons, a brief seasonal outline of topics is given for the fall and spring terms, immediately following the main outline, suggesting the order in which the various topics may most effectively be studied. This seasonal outline is arranged to meet the requirements of the seasons in southern Minnesota. Some modifications will need to be made for States farther south.

Age of child. The child is the fundamental consideration that determines the main features of the outline. For the primary grades those plants and animals have been chosen which the children could most naturally and easily be led to observe, on account of their bright colors, large size, activities, or common occurrence. The chief emphasis is placed on identification.

In the intermediate grades the plants and animals have been classified into groups based on their habitat and habits. Identification still remains a prominent factor, as in the primary grades, but to this are added the idea of adaptation of plants and animals to their surroundings, and their classification into groups as mentioned above. Children's plays and sports have been made the center around which some simple studies in physics have been grouped.

In the grammar grades the general thought is the relation of these various phases of science to human welfare. Two centers have been chosen around which to group these topics, the home in the seventh grade, and community life in the eighth grade.

In connection with the various topics in the outline there have been given corresponding children's problems which may serve as the central thought of the lesson, suggesting the points to be considered.

Principles followed in constructing the science outline. The principles used in the organization of the outline given in the following chapter may be briefly summarized as follows:—

1. The course should cover all phases of elementary science adapted to the grades. (Biology, hygiene, elementary agriculture, elementary physics and chemistry, astronomy.)

2. This material should be organized from the child's standpoint, and not the adult's.

3. The basis for organization should be found in the child's needs and interests, instead of in the subject-matter.

4. This basis should be found in the needs and interests of the child's present life or of his immediate future, instead of in those of the distant future.

5. The arrangement of topics should depend on the seasons.

6. The course should be adapted to local conditions.

7. In the lower grades the dominant purpose should be the æsthetic; in the upper grades the dominant purposes should be the economic and social.

8. The topics for the primary grades should deal largely with the study of plants and animals; the work for upper grades should cover all phases of elementary science.

9. The topics for study in the primary grades should include the most conspicuous plants and animals in the child's environment, selected from the standpoint of color, activities, size, and occurrence.

Brief synopsis of outline. In order that the general plan and organization of the outline may be seen at a glance, a brief synopsis of the detailed outline found in the pages following is given here.

First Grade

Autumn

I. Nature's Autumn Colors.

Flowers: nasturtium, wild sunflower; colored leaves: maple and box elder.

II. Preparation for Winter.
Food; garden; seeds; animal preparation.
III. Seasonal Changes.
Approach of autumn and winter; weather records.

Winter

I. Holiday Studies.
Christmas dinner; trees; flowers.
II. Home Studies.
Pets; the cat.
III. Health Studies.
Foods; air; bathing; clothing.
IV. Weather Studies.
Weather records; uses of ice and snow.

Spring

Central thought: the returning spring

I. The Awakening Trees.
Maple, box elder, pussy willow, and poplar.
II. The Awakening Flowers.
Dandelion, Jack-in-the-pulpit.
III. The Awakening Seeds.
Lima bean, dwarf nasturtium.
Schoolroom gardening; home gardens.
IV. The Returning Birds.
Robin, bluebird.
V. New Life among Animals.
VI. The Changing Season.
Wind; rain; changes in brook; weather records.

SECOND GRADE

Autumn

I. Nature's Autumn Colors.
Flowers: goldenrods, thistle; colored leaves: elm, linden.
II. Animal Activities.
Spider, grasshopper, cricket.
III. Preparation for Winter.
Food; gardens; seeds; animal preparation.
IV. Seasonal Changes.
Approach of autumn and winter; weather records.

Winter

I. Holiday Studies.
Christmas dinner; trees; flowers.
II. Home Studies.
Pets; the dog.
III. Health Studies.
Air; bathing; clothing.
IV. Weather Studies.
Weather records; forms of ice and snow.

Spring

Central thought: the returning spring

I. The Awakening Trees.
Elm, linden.
II. The Awakening Flowers.
Hepatica, spring beauty.
III. The Awakening Seeds.
Pea, radish, climbing nasturtium.
Schoolroom gardening; home gardens.
IV. The Returning Birds.
Red-winged blackbird, Baltimore oriole, chimney swift.
V. New Life among Animals.
Toad's eggs.
VI. The Changing Season.
Signs of spring; changes in brook; weather records.

THIRD GRADE

Autumn

I. Nature's Autumn Colors.
Flowers: the asters; colored leaves: oaks, fruit trees.
II. Animal Activities.
Mosquitoes.
III. Preparation for Winter.
Food; gardens; seeds; animal preparation.
IV. Seasonal Changes.
Approach of autumn and winter; weather records.

Winter

I. Holiday Studies.
Christmas dinner; trees; flowers; Christmas dinner for the birds.

II. Home Studies.
Child's home; homes of animals.
III. Health Studies.
Food; air; bathing; clothing.
IV. Weather Studies.
Weather records; freezing; evaporation; condensation.

Spring

Central thought: the returning spring

I. The Awakening Trees.
Oaks and fruit trees.
II. The Awakening Flowers.
Violets.
III. The Awakening Seeds.
Corn, zinnia.
Schoolroom gardening; home gardens.
IV. The Awakening Animals.
Moth for cocoon; turtles.
V. The Returning Birds.
Scarlet tanager, rose-breasted grosbeak, house wren; nesting-house for wren; Audubon Bird Club.
VI. New Life among Animals.
Ways of hatching hen's eggs.
VII. The Changing Season.
Signs of spring; changes in brook; weather records.

Fourth Grade

Autumn

I. Garden Studies.
Cultivated flowers — hardy annuals; bulbs; root vegetables.
II. Plants in Nature's Garden.
Flowers of shady places; mushrooms; nut trees.
III. Some Animal Friends and Foes.
Earthworms; insects — social insects; insect activities.
IV. Aquarium Studies.
Fishes.
V. Fall Sports.
The swing and slide.

Winter

I. Plants in Winter.
Shapes of trees; winter decorations.
II. Health Studies.
Food; air; sleep; the eyes; lighting the home.
III. Christmas Toys.
Motor, magnet, steam engine, flying machines.
IV. Winter Sports.
Coasting.
V. Sky Studies.
The sun.

Spring

I. The Awakening Life of Spring.
Nut trees; brightly colored wild flowers; cultivated flowers from bulbs.
II. The Returning Life of Spring.
Birds of the dooryard and shade trees; fountains; nesting-houses for wren; Audubon Bird Club.
III. Gardening.
Hardy annual flowers and root vegetables.
Schoolroom gardening; home gardens.

Fifth Grade

Autumn

I. Garden Studies.
Tender annual flowers; bulbs; house plants; vegetables whose fruits or seeds are eaten.
II. Plants in Nature's Garden.
Flowers that grow in sunny places; ferns; shade trees; plants that move.
III. Some Animal Friends and Foes.
Water insects; flies; spiders; crayfish.
IV. Some Plant Foes.
Poisonous plants.
V. Aquarium Studies.
Scavengers of the aquarium — snail and tadpole.
VI. Fall Sports.
Giant stride and teeter.

Winter

I. Plants and Animals in Winter.
Bark of trees; winter decorations; winter birds.
II. Health Studies.
Drinks; food; breathing; clothing; skin.
III. Winter Pleasures.
Outdoor sports; evening entertainments.
IV. Sky Studies.
The moon.

Spring

I. The Awakening Life of Spring.
Shade trees; white spring flowers; cultivated perennial flowers.
II. The Returning Life of Spring.
Birds of the air; nesting-houses for wren and bluebird; nesting-habits; Audubon Bird Club.
III. The New Life of Spring.
Frog's eggs.
IV. Gardening.
Tender annual flowers and vegetables whose leaves are eaten.
Schoolroom gardening; home gardens.

Sixth Grade

Autumn

I. Garden Studies.
Vines; vine crops; flowers from spring-planted bulbs; planting fall bulbs; fruit trees; weeds of the garden.
II. Plants in Nature's Garden.
Vines; shrubs; mosses and lichens; tree fruits; fruits for winter birds.
III. Some Friends and Foes of the Garden.
Insects; birds; toads.
IV. Aquarium Studies.
Water plants.
V. Fall Sports.
Bicycling.

Winter

I. Plants and Animals in Winter.
Buds of trees; winter decoration; birds.
II. Health Studies.
Foods; heating and ventilation; clothing; avoiding disease; the blood system; accidents.
III. Christmas Studies.
Evergreens.
IV. Winter Sports.
Roller skating.
V. Sky Studies.
The Stars and planets.
VI. Some Simple Machines that make Man's Work easier.
Pulley, screw, wedge.
VII. How Glass Helps People.
Spectacles, opera glasses, camera.
VIII. Helps in Being Prompt.
Watches and clocks; school electric bell; old methods of telling time.

Spring

I. Awakening Life of Spring.
Fruit trees; cultivated shrubs.
II. The Returning Life of Spring.
Birds of the meadows and fields and of marshes; bird enemies; work of Audubon Society; migration; open nesting-houses; Audubon Bird Club.
III. Gardening.
Vines and vine crops.
Schoolroom gardening; home gardens.
IV. Spring Sports.
Outdoor toys: kite, windmill, water wheel.

SEVENTH GRADE

Central thought for the grade: the hygiene and science of the home

Autumn

I. Making the Home Yard Attractive.
Shrubs; vines; flowers.

II. Making the Yard Useful.
The vegetable and fruit gardens.
III. Insect Pests of the Household.
IV. Heating the Home.
V. Ventilating the Home.

Winter

I. Lighting the Home.
II. The Home Water Supply.
III. The Food Supply.
IV. Entertainment in the Home
Musical instruments.

Spring

I. Making the Yard Attractive.
Shrubs; vines; flower garden.
II. Making the Yard Useful.
Vegetable and fruit gardens; bee-keeping; poultry-keeping.
III. Enemies of the Garden.
Injurious insects.
IV. Friends of the Garden.
Beneficial insects; toads; birds; attracting birds around the home; bird songs and plumage.
V. Soils of the Garden.

Eighth Grade

Central thought for the grade: the sanitation and science of community life

Autumn

I. Insects that Threaten Health.
Fly and mosquito.
II. Insects in Relation to Growing Crops.
Insect foes; insect friends.
III. Plant Enemies of Crops.
Weeds; fungous diseases.
IV. Forest Trees.
V. Means of Travel.
On land; on water; in the air.
VI. Means of Communication.
Telephone and telegraph.

Winter

I. Public Health and Sanitation.

Board of health; milk supply; food supply; water supply; contagious diseases; sewage disposal; parks and playgrounds; fire protection; care of streets; lighting.

II. School Hygiene.

Ventilation and heating; lighting; drinking-fountains; playgrounds; medical inspection.

Spring

I. Forestry.

Uses of forests; decrease; enemies; forest control; reservations; conservation; Bureau of Forestry; uses and structure of woods; work of the parts of a tree.

II. Bird Friends of the Forests.

Special study of birds of the woods; economic value of birds; adaptations in the structure of birds; enemies; work of National Government to protect birds.

CHAPTER XIX

DETAILED OUTLINE OF SCIENCE BY TOPICS AND PROBLEMS

(Arranged according to Grades and Seasons)

FIRST GRADE

Autumn

I. Nature's Autumn Colors.

1. Gathering wild flowers; excursion to gather bouquet for schoolroom; group according to color; flower games; make flower chart. Special study of wild sunflower.
2. Flowers from home and school gardens; compare with colors of wild flowers; make a booklet "Mother's Garden."
3. Special study of dwarf nasturtium, the garden flower suggested for spring planting.

Problems —

How many different colors can we find among the flowers that grow around here?

Have the garden flowers the same colors as the wild flowers?

How can we tell the nasturtium the next time we see it? (See page 119.)

How can we have more nasturtiums for next year?

4. Autumn coloring of leaves.
   - A. Gather a variety of colored leaves; group according to color.
   - B. Special study of maple and box-elder.

Problems —

How many different colors can we find among the autumn leaves? (See page 95.)

How can we tell a maple tree from a box-elder tree?

II. Preparation for Winter.

1. Food for the winter.

A. Study of vegetables grown around the locality.

B. Trip to grocery store: names of fruits and vegetables seen; note farmers' wagons.

Problems —

What things have been done so that we might have these tomatoes? (See page 119.)

What vegetables that we eat were grown in our own locality?

How do they grow in the garden?

Which vegetables grow on top of the ground and which in the ground?

How do the vegetables get from the farmer to the grocer?

2. Provision for winter and spring gardens.

A. Indoor planting of Chinese lily bulb in water. (See page 126.)

B. Outdoor planting of daffodil.

Problems —

How can we have flowers of the Chinese lily in our schoolroom before Christmas?

How can we have early spring flowers outdoors?

3. The seeds for next year.

A. Treasure boxes — fruits and vegetables.

B. Nature's seed sowing-seeds that fly.

Problems —

What kind of seeds can we find in the fruits and vegetables that we eat?

How are some seeds made so they can fly? (See page 105.)

4. Animal preparation for winter.
   - A. The squirrel gathering his winter store.
   - B. Caterpillars spinning cocoons; rear caterpillars in schoolroom.
   - C. The fish in winter quarters — aquarium studies.

Problems —

How does the squirrel get ready for winter?

We will watch the caterpillar and see how it grows up.

What care will the fish in our aquarium need this winter?

How does the fish live in water?

III. Seasonal Changes.

1. The approach of autumn — first week of term. Chart — "autumn work and play."
2. The approach of winter — last week of term. Booklet — "getting ready for winter."
3. Weather records kept for one month (October). Pictorial records on large cards showing sunny days, cloudy days, rainy days, windy days. (See page 185.)

Problems —

What signs do you see that autumn is coming?

What signs do you see that winter is coming?

TOPICS ARRANGED IN SEASONAL ORDER

September	*October*	*November*
Approach of autumn	Rear caterpillars	Weather records
Wild flowers	Plant daffodil	Vegetables
Plant lily bulb	Seeds that fly	Squirrel
Cultivated flowers	Trees	Fish
	Treasure boxes	Approach of winter

Winter

I. Holiday Studies.
   1. Christmas dinner.
      A. Local products.
      B. Special study of turkey and pumpkin.
   2. Christmas trees — the pine.
   3. Flowers for the Christmas table; Chinese lily from bulb planted in the fall.

   Problems —

   What can we get for our Christmas dinner from the farms near here?
   How do people raise turkeys?
   How can we make a Jack-o'-lantern?
   How can we tell a pine from other Christmas trees?
   What has happened to this bulb since we planted it last fall?

II. Home Studies.
   1. Care of pets — the cat.

   Problems —

   To what extent can cats take care of themselves? (See page 85.)
   How can we take the best care of our pet cats?

III. Health studies.
   1. Foods that help make children strong. The cow as the source of milk, butter, and cheese. Make butter in schoolroom. (See page 86.) Make a "Good Breakfast" chart.
   2. Fresh air; games played outdoors; how to get fresh air in schoolroom.
   3. Bathing. Children make individual "Keep Clean" charts.
   4. Clothing — special study of cotton and woolen goods.

Problems —

How does the cow help us to get foods? (See page 86.)

How should people take care of their cows?

How do we get fresh air in the schoolroom?

Why should we keep our face and hands clean?

Where did your apron come from?

Where did your winter dress come from?

IV. Weather Studies.

1. Weather records, kept for one month (January). (See fall outline.)
2. Uses and forms of ice and snow.

Problems —

How does Jack Frost make us happy?

What kind of pictures does Jack frost paint?

Let us make a chart showing Jack Frost's work.

Spring

Central thought: the returning spring

I. The Awakening Trees.

1. Study of twigs of box-elder and maple kept in water indoors.
2. Study of development of buds outdoors; flowers of soft maple.
3. Special study of pussy willow and pussy poplar.
4. Maple sugar.

Problems —

What can we find on the twigs of the box-elder and maple?

When the buds open what can you see coming out of the buds?

Why do you like the pussy willow?

Where does maple sugar come from?

II. The Awakening Flowers.
1. Daffodils from bulb planted in fall.
2. Calendar of wild flowers.
3. An excursion for flowers for the May basket?
4. Special study of dandelion and Jack-in-the-pulpit.

Problems —

Why do you like the daffodil?

What colors did you find for your May basket?

How can you tell the dandelion from other flowers?

Why do you think Jack-in-the-pulpit is an interesting flower?

III. The Awakening Seeds.
1. Schoolroom gardening.
   - A. Plant seeds of dwarf nasturtium and Lima bean.
   - B. Experiments with seeds and seedlings.
     - *a.* What do seeds need to grow? (See page 131.)
     - *b.* Will seeds grow better in dirt or water? In dry or moist dirt?
     - *c.* What effect does soaking have on seeds?
2. Home gardens.
   - A. Order envelopes of penny packets of seeds distributed.
   - B. Lessons on planting a few common seeds. Home gardens visited by teacher.

Problems —

We will start a little garden indoors and plant the nasturtium and bean seeds, so we can see how they grow.

We will learn how to plant radish seeds, so that you can plant them at home.

IV. The Returning Birds.

1. Bird calendar. (See page 52.)
2. Bird walks.
3. Special study of robin and bluebird.
4. Meetings of Audubon Bird Club.

Problems —

How can we tell the bluebird when we see it? (See page 64.)

Why do you like the robin?

V. New Life among Animals.

1. Study of hen and chickens.

Problems —

How does a hen care for her chickens?

VI. The Changing Season.

1. The wind. Make a windy scene in a box.
2. Spring rains.
3. Weather records for a month (April). (See page 185.) Decorate margin of pictorial record with pictures of signs of spring.
4. Changes in the brook. Make a "growing" picture of the brook, adding drawings of new life that appears.
5. Lessons at beginning and end of term on changes in seasons.

Problems —

Of what use is the wind?

Why do you like a rainy day?

How is the brook different now than it was a few weeks ago?

What signs do you see of the coming of spring?

SEASONAL ORDER OF TOPICS

March	*April*	*May*
Distribute seed envelopes	Weather record	Jack-in-the-pulpit
The wind	Spring rains	Bank swallow
Change of seasons	Flower of soft maple	Hen and chickens
Twigs of trees	Changes in brook	Bird walks
Plant seeds indoors	Robin	Daffodil
Experiments with seeds	Pussy willow	Excursions for flowers
Bird calendar started	Lessons on home gardens	Change of seasons
Maple sugar	Flower calendar	
	Dandelion	
	Bluebird	

SECOND GRADE

Autumn

I. Nature's Autumn Colors.

1. Gathering wild flowers. Looking for new flowers. A flower card for each new flower hung in room.
2. Special study of goldenrod and thistle.
3. Flowers from home and school gardens; use in schoolroom.
4. Study of climbing nasturtium, the garden flower suggested for spring planting.

Problems —

How can we tell the goldenrod from other flowers? (See page 102.) Why do you like the nasturtium?

5. Autumn coloring of leaves.
   - A. Study of coloring of leaves of trees on school grounds.
   - B. Special study of elm and linden.

Problems —

How many different colors can we find on the leaves of trees growing on the school grounds?

How can we tell the elm and linden trees apart?

II. Animal Activities.
1. Grasshopper and cricket; keep indoors in cage.
2. Spiders; special study of webs.

Problems —

We will watch the grasshopper in the cage to see how many different ways of moving it has. (See page 74.)

We will watch the cricket to see how it makes its song.

What kind of webs do spiders make? (See page 80.)

III. Preparation for Winter.
1. Food for the winter.
   A. Study of home-grown fruits; make charts. Have children each bring some kind of fruit to see how many colors they can find.
   B. Trip to grocery store. Canned fruits and vegetables.

Problems —

What fruits that we eat are raised in our own State?

What canned goods are put up in our own State?

2. Provision for winter and spring gardens.
   A. Indoor planting in soil and water of bulb of paper-white narcissus. (See page 126.)
   B. Outdoor planting of crocus.

Problems —

How can we have some flowers in our room next winter?

How can we get some early spring flowers outdoors?

3. Seed for next year.
   A. Seeds from home and school gardens stored.
   B. Nature's seed sowing — seeds that steal a ride?

Problems —

What seeds from our garden can we save to plant next spring?

How are some seeds made so that they can steal a ride? (See page 106.)

4. Animal preparations for winter.
   - A. The rabbit in the fall; his winter quarters.
   - B. Fish in winter quarters; aquarium studies; need of plant life.

Problems —

What may we learn about the habits of the rabbit from a study of the one kept in our schoolroom?

Why do we keep plants in the aquarium?

IV. Study of Seasonal Changes.

1. Approach of autumn — first week of term. Autumn pictures painted. A park in autumn; compare with spring.
2. Approach of winter — last week of term. Winter landscape painted.
3. Weather records for one month (September). Records in writing on blackboard or chart showing temperature, winds, clouds, interesting weather happenings. (See page 185.)

Problems —

How does our park now differ from the way it looked last spring?

What signs do you see that winter is coming?

SEASONAL ORDER OF TOPICS

September	*October*	*November*
Weather records	Spider	Fruits
Approach of autumn	Grasshopper	Plant narcissus bulb
Wild flowers	Cricket	Rabbit
Cultivated flowers	Plant crocus	Fish
	Seeds that steal a ride	Approach of winter
	Storing seeds	
	Trees	

Winler

I. Holiday Studies.
   1. Christmas dinner.
      A. State products.
      B. Special study of nuts and fruits of our State.
   2. Christmas trees — spruce and red cedar.
   3. Flowers for the Christmas table; paper-white narcissus from bulb planted in the fall.

   Problems —
   What kinds of nuts grow in our State?
   How do people raise fruits in this State?
   Why does the spruce make a good Christmas tree?
   How can we tell a red cedar from other Christmas trees?
   Why is it nice to have this narcissus flower in the room?

II. Home Studies.
   1. Home of Eskimo children.
   2. Care of pets — the dog and the canary.

   Problems —
   How do the homes of the Eskimo children differ from your homes?
   To what extent can the dog take care of himself?
   What care should I give my dog? (See page 85.)
   How many kinds of dogs are there? (See page 83.)
   Of what use are dogs? (See page 84.)
   What are some of the wild animal cousins of the dog?
   What makes the canary an interesting pet?

III. Health Studies: How to keep well and strong in winter.
   1. Fresh air; how to get fresh air indoors at home.
   2. Bathing; need of keeping hands clean.

3. Clothing — study of silk and leather.
4. Good drinks for children; milk and water.

Problems —

How can we get fresh air in our homes?
Why should we wash our hands before eating?
Where did your new silk tie come from?
How are our shoes made?
Why is milk a better drink than coffee for children?

IV. Weather Studies.

1. Weather records for one month (December). Written records on chart or blackboard. (See fall outline.)
2. Uses and forms of snow and ice. Charts: Work Which Snow Makes; Work Which Snow Helps; Fun Which the Snow Brings.

Problems —

How does snow help people?
What fun does the snow bring us?

Spring

Central thought: the returning spring

I. The Awakening Trees.

1. Study of twigs of elm and linden kept in water indoors.
2. Study development of buds of these trees outdoors.
3. Flower of elm and linden.

Problems —

How do the twigs of the elm and linden differ?
Which comes out first on these trees, leaves or flowers?
How are the flowers of the elm different from the other spring flowers?

II. The Awakening Flowers.
1. Crocus from bulb planted in the fall.
2. Calendar of spring wild flowers.
3. Excursion for flowers for May basket.
4. Special study of hepatica and spring beauty.

Problems —

How can we tell the crocus from other spring flowers?

Why do you like the hepatica?

How can you tell the hepatica and spring beauty apart?

III. The Awakening Seeds.
1. Schoolroom gardening.
   - A. Plant indoors seeds of pea, radish, and climbing nasturtium.
   - B. Eggshell garden — plant seeds in eggshells. (See page 130.)
   - C. What do plants need to grow? (Answer by experiments.)
     - *a.* Do plants need water?
     - *b.* Do plants need light? (See page 134.)
2. The home garden.
   - A. Distribute seed envelopes for penny packets.
   - B. Encourage children to plant seeds mentioned above (III, 1, A).
   - C. Lesson on how to get the garden ready and how to plant these seeds.
   - D. Write for garden catalogues.

Problems —

We will plant some radish seeds to see if we can raise some radishes indoors before school closes.

How shall we get our garden ready at home for planting seeds?

IV. The Returning Birds.

1. Bird calendar. (See page 52.)
2. Bird walks.
3. Special study of red-winged blackbird, Baltimore oriole, and chimney swift.
4. Building nesting-houses for the wren.
5. Organization of Audubon Bird Club, and meetings through term.

Problems —

How can we tell each of these birds when we see them outdoors?

How does the swift differ from the oriole in its habits?

Which do you think is the most interesting bird?

What kind of a house shall we build for the wren? (See page 65.)

Why would it be nice for us to form a Bird Club?

Why would you like to have a pair of orioles nest in your yard?

V. New Life among Animals.

1. Development of toad's eggs.

Problem —

What happens to the toad's eggs as they grow?

VI. The Changing Season.

1. Signs of spring. Booklet — Pictures of all the new happenings outside.
2. Weather records for a month (March). Written records on blackboard or chart. (See fall outline.)
3. Study of changes in brook. Animal life in the brook. Picture of the brook in March and May.

Problems —

Who has seen the greatest number of signs of spring?

What animals live in our brook?

SEASONAL ORDER OF TOPICS

March	*April*	*May*
Give out seed envelopes	Bird calendar	Toad's eggs
Weather records	Flowers of elm	Swift
Signs of spring	Bird-houses	Oriole
Twigs of trees	Bird club	Excursion for flowers
Plant seeds	Flower calendar	Bird walks
Experiments with plants	Hepatica	
Changes in brook	Home garden	
	Spring beauty	
	Crocus	

THIRD GRADE

Autumn

I. Nature's Autumn Colors.

1. Gathering wild flowers — excursions. Recall old flowers; add new ones.
2. Special study of the different kinds of wild asters: flower cousins, wild and cultivated asters.
3. Comparison of fall and spring flowers.
4. Gathering flowers from home and school garden; method of raising them.
5. Special study of zinnia, the garden flower suggested for spring planting.
6. Insects seen around flowers — butterflies, bees.

Problems —

What new flowers can you find this fall?

How many different kinds of asters can we find growing around here this fall?

How are the wild and cultivated asters alike?

How do the flowers we see now differ from those we saw last spring?

Why is the zinnia a good flower to grow in our gardens?

What do we have to do in order to get these flowers?

What colors do you find on butterflies?
Why do bees come to the flowers?

7. Leaf coloring.
   A. Study of coloring of leaves of trees growing along the streets and in the children's yards.
   B. Special study of fruit trees and oaks.

Problems —
How does the coloring on the different kinds of trees growing in your yard differ?
How can we tell the different kind of oaks apart?
Of what use is the oak?
How can you tell the apple tree by its leaves?
Let us see how many different kinds of apples we can collect?

8. Plants without flowers.
   Ferns and mushrooms.

Problem —
How do ferns and mushrooms differ from our fall flowers such as the goldenrod?

II. Animal Activities.

1. Mosquitoes; keep wigglers in tumbler.

Problem —
How do these wigglers live in the water? (See page 77.)

III. Preparation for Winter.

1. Food for the winter.
   A. Study of fruits grown outside of our State.

Problems —
What fruits that we eat are grown outside of our State?
How do these fruits get to us?

2. Provision for winter and spring gardens.
   - A. Raising plants from cuttings. (See page 128).
   - B. Planting bulb of Dutch hyacinth indoors. (See page 126.)
   - C. Planting bulb of Dutch hyacinth out of doors.

Problems —

We will learn a new way of getting flowers, that is by using cuttings.

How can we have flowers in our room next winter?

How can we have flowers out of doors in the spring?

3. Seed for next year.
   - A. Nature's seed sowing — seeds that shoot, and those scattered by birds.

Problems —

How are some plants fitted so as to shoot their seeds?

How do birds help scatter seeds?

4. Animal preparation for winter.
   - A. The tadpole in winter quarters — aquarium studies.
   - B. Departure of birds; comparison with bird life in the spring; Bird Clubs meet to report on experiences with bird-houses the previous summer.
   - C. The long winter sleep of animals.
     - *a.* Hibernation of toad, frog, snakes, turtles.

Problems —

What does the tadpole do in the aquarium?

What birds of the springtime are still here?

How do animals like the toads and frogs spend the winter?

5. Plant preparation for winter; trees, grasses, flowers.

Problem —

How do plants like trees, flowers, and grasses get ready for winter?

IV. Seasonal Changes.

1. The approach of autumn — first week; written records.
2. The approach of winter — last week; written records.
3. Weather records for one month (November). Individual records in writing.

Problem —

Let us see who can write the longest list of things that show autumn is coming, or that winter is coming.

SEASONAL ORDER OF TOPICS

September	*October*	*November*
Wild flowers	Flowerless plants	Weather records
Approach of autumn	Seeds	Fruits
Cultivated flowers	Trees	Tadpole
Mosquitoes		Approach of winter
Cuttings		

Winter

I. Holiday Studies.

1. Christmas dinner; products from abroad.

Problems —

What are some of the things for Christmas dinner that come from other parts of the world than our own State?

How do they get to us?

What nuts do we get that are raised outside of our State?

2. Christmas dinner for the birds. (Use old Christmas tree.)

Problems —

What kind of Christmas gifts do birds like?

What kind of birds will come to the feast?

3. Christmas greens.

A. Christmas trees — evergreens of our locality.

B. Holly and mistletoe.

Problems —

How can we tell the evergreens of our locality apart? (See page 95.)

Why are holly and mistletoe used for decorations?

4. Flowers for the Christmas table. Dutch hyacinth planted in fall.

Problems —

What has happened to this bulb since we planted it?

Why has it been worth while to raise this flower?

II. Home Studies.

1. Child's home.

A. Warming the home — the thermometer.

B. Lighting the home (compare with primitive methods).

Problems —

In how many different ways are our homes warmed?

How can we tell from the thermometer when the room is warm enough?

How do our ways of lighting our homes differ from the ways that were used many, many years ago?

2. Homes of animals.

A. Deserted homes — birds' nests.

B. Insect homes — galls, cocoons, nests of paper and mud wasps.

C. Domesticated animals, the cow and horse.

Problems —

Of what materials do birds make their nests?
What kind of homes do wasps make?
What kind of homes do the gall-dwellers live in? (See page 75.)
Of what kind of materials are insect homes made?
How are insect homes made?
In how many ways is the cow useful to us? (See page 86.)
Of what use is the horse?
How many different kinds of horses are there?
How should horses be cared for?

III. Health Studies.

1. Foods that help keep one well and strong. Emphasize the sources; the industrial relations.
2. Fresh air; need of, how get in sleeping-room.
3. Bathing; cold and warm water baths.
4. Clothing — study of fur and linen.
   A. Classify clothing materials into plant and animal products.

Problems —

What are some of the foods that are good for us to eat?
How does an orange get to us?
Why do we need fresh air?
How can we get fresh air in our sleeping-rooms?
Which is better, the warm water or cold water bath?
How did your father get his fur coat?
Where did your handkerchief come from?

IV. Weather Studies.

1. Weather records for one month (February). Written individual records. (See page 185.)
2. Condensation, evaporation, freezing. (See page 172.)

Problems —

How can we show that there is water in the air of this room? (See page 172.)

What happens when water boils?

What harm is done by freezing water? (See page 172.)

What good is done by freezing water?

Spring

I. The Awakening Trees.

1. Study of twigs of oaks and fruit trees kept in water.
2. Development of buds outdoors.
3. Study of flowers of fruit trees.
4. Calendar of blossoming trees.

Problems —

How can we tell these twigs apart before the leaves come out?

Which appear first, the leaves or blossoms on the oaks and fruit trees?

What are the names of the parts of an apple blossom?

Why do you like the apple blossom?

II. The Awakening Flowers.

1. Dutch hyacinth from bulb planted in fall.
2. Calendar of wild flowers.
3. Excursion for wild flowers for May basket.
4. Special study of dog-toothed violet and the blue, white, and yellow violets.

Problems —

What do you like about this hyacinth flower?

How may the different violets be told apart?

What are the names of the parts of a violet flower?

Of what use is each part of the violet flower?

III. The Awakening Seeds.

1. Schoolroom gardening.
   - A. Plant indoors seeds of corn and zinnia.
   - B. Experiment to show use of cotyledon of pea to seedling.
2. Home gardens.
   - A. Distribute order envelopes for penny packets of seeds.
   - B. Lesson on home gardens; planting seeds, use, care; gardens visited by teacher.
   - C. Charts showing pictures of flowers easily grown and of vegetables easily grown. Reports on father's garden.

Problems —

We will plant seeds of corn and zinnia so as to watch the plants and see how fast they grow.

Why would you like to have a garden?

What must you do if you wish to have a garden this spring?

How should seeds be planted? (See page 125.)

IV. The Awakening Animals.

1. Turtles, frogs, snakes.
2. Development of moth from cocoons collected in fall and winter or from the caterpillars reared in fall.

Problems —

How do turtles differ from other animals that you know?

How is this moth (or butterfly) different from other insects that you know, such as the grasshopper?

V. The Returning Birds.

1. Bird calendar. (See page 52.)

2. Bird walks.
3. Special study of house wren, scarlet tanager, and rose-breasted grosbeak.
4. Building nesting-houses for the wren.
5. Audubon Bird Club organized and meetings held through term.

Problems —

Which do you think is the prettier bird, the tanager or grosbeak?

How can we tell these from other birds?

Why would you like to have a wren nest around your home this summer?

What kind of a house shall we make for a wren to nest in? (See page 65.)

What can our Bird Club do to help the birds?

VI. New Life among Animals.

1. Methods of hatching hen's eggs.

Problem —

Which is the better way of hatching eggs, to use an incubator or let the hen do it?

VII. The Changing Season.

1. Signs of spring. Collection of pictures, making booklet to show spring's return.
2. Weather record for one month (May). Individual record kept in writing.
3. Changes in brook. Visit brook. Note changes included in signs of spring. Pictures of brook in March and May.

Problems —

Let us make a collection of pictures to show signs of spring.

How does the brook in May look different than it did in March?

SEASONAL ORDER OF TOPICS

March	*April*	*May*
Give out seed envelopes	Bird calendar	Weather record
Twigs of trees	Start bird club	House wren
Plant seeds indoors	Lessons on home garden	Moth
Signs of spring	Calendar of tree flowers	Grosbeak
Use of food in pea	Turtles	Hyacinth
Changes in brook	Flower calendar	Flowers of fruit trees
	Violets	Tanager
	House for wren	Excursions for flowers
	Hatching eggs	Bird walks
		Changes in brook

FOURTH GRADE

Autumn

I. Garden Studies.

1. Report on summer experiences in the garden.
2. Cultivated flowers — hardy annuals, such as bachelor's button, candytuft, nasturtium, phlox, California poppy, sweet alyssum, petunia, zinnia.

Problems —

Which would you prefer to have in your garden, the nasturtium or bachelor's button? (Or comparison of any two flowers.)

What are the best ways of telling these flowers apart? (Taking one or two at a time.)

Why do you like the nasturtium?

3. Planting bulbs.
   - A. For outdoor planting — tulips (single, double, Darwin, parrot); daffodils (single, double); jonquils (single, double). (Plant in school garden and encourage the children to plant at home.)
   - B. For indoor blooming during the winter — double jonquil or daffodil. (See page 126.)

Problems —

How may we get flowers in the early spring?

How may we have flowers in the schoolroom next winter?

4. Vegetables whose roots are eaten; such as beet, carrot, oyster plant, parsnip, turnip, kohlrabi, celeriac. (Make carrot basket.) (See page 133.)

Problems —

How are root vegetables grown?

Which of these makes the best kind of food?

In what ways are these vegetables cooked?

II. Plants in Nature's Garden.

1. Flowers that grow in shady places, such as wood aster, tall bell flower, boneset, cone flower, elm leafed goldenrod, white lettuce, white snakeroot, woodland sunflower, touch-me-not, lobelia.

Problems —

What is the best way of telling each of these flowers from other flowers?

Which do you like the better of any two of these flowers?

2. Plants without flowers.

A. Mushrooms.

Problems —

What are the parts of a gill-bearing mushroom?

How do the various mushrooms differ from each other? (See page 107.)

3. Nut trees; such as butternut, walnut, hickories, oaks. Keep calendar of coloring and fall of leaves. (See page 92.)

Problems —

How can we tell the oaks apart by their leaves?

How do the acorns of the oaks differ?

What use is made of the wood of oak trees?
How can we tell a butternut from a walnut tree?

III. Some Animal Friends and Foes.
1. Social insects such as ants, bees, wasps.
2. Insect activities; how they eat, breathe and move.

Problems —
What can we learn about the habits of ants from a study of ants kept in a nest in the schoolroom?
In what ways is the life of social insects like the social life of human beings?
How do insects eat? (See page 75.)
In how many ways do insects move? (See page 75.)
How does the insect's way of breathing differ from our way? (See page 75.)

3. Earthworms.

Problems —
In what ways are earthworms helpful to man?

4. Squirrels.

Problems —
What makes squirrels interesting animals to have around?
How many kinds of squirrels are there?

IV. Aquarium Studies — fishes, fishes used as food, native fishes.

Problems —
How does the fish use its fins in swimming?
How does its method of breathing differ from that of the frog?
To what extent do we use fishes for food in our town?
What fishes are found around our locality?

V. Fall Sports.

1. The swing; other applications of the pendulum, such as the clock. Simple experiments showing relation of length, weight, and arc to time of vibration. (See page 179.)
2. The slide; other applications of the inclined plane; such as coal slide, plank for loading wagon, sliding down hill. (See page 180.)

Problems —

What principles of the pendulum are illustrated in the swing?

What other applications of the pendulum can you find?

What other applications of the inclined plane can you find beside the swing?

SEASONAL ORDER OF TOPICS

September	*October*	*November*
Wild flowers	Cultivated flowers	Squirrels
Soft mushrooms	Insects	Bulbs — indoors
Cultivated flowers	Bulbs — out of doors	Fish
	Earthworm	Vegetables
	Trees	Woody mushrooms
		Swing and slide

Winter

I. Plants in Winter.

1. Winter decorations — flower of jonquil or daffodil planted in fall.
2. Shapes of trees.

Problems —

What makes this an attractive plant to have in the schoolroom?

How do trees differ in their shape?

II. Health Studies; how to keep the body well and strong.

1. Foods.

A. Foods that are good for children. Emphasize the use of plain, simple foods such as fruits, vegetables, meats, cereals.

B. Foods that are not good for children. Emphasize the need of extreme caution in using such foods as rich cakes, pastries, fatty meats, rich puddings.

C. For each food discuss its sources, means by which it reaches the table, final preparation for table, value as food.

D. Need of thorough chewing, care of teeth, different sets of teeth.

Problems —

What are the most wholesome foods for us to eat?

What are some of the foods that it is better to leave alone or eat only small portions of?

Why should we take good care of our teeth?

How can we take good care of our teeth?

2. Air.

A. Uses in motion; to sail boats, turn windmills, dry clothes, keep one comfortable in summer.

B. Uses when quiet; to make fires, lamps, and gas jets burn; use to animals, plants, and people in breathing.

Problems —

Of what use is air when in motion?

Of what use is air when quiet?

3. Care of eyes and ears.

A. How to read, testing the eyes, use of glasses, testing the ears.

Problems —

In what ways should we be careful in using our eyes?

How do spectacles help the eyes?

4. Methods of lighting the home. (See page 170.)

A. Candle, lamp, gas, electricity.

Problems —

Which is the best way of lighting the home?

How does the method of using gas differ from that of electricity?

5. Sleep; providing rest for the body.

A. Need of sleep, amount required, how to get fresh air in sleeping-rooms.

Problem —

On what does the amount of sleep that one needs depend?

III. Christmas toys; such as magnets, electro-magnet, motor, steam engine, air ships, gyroscope, compass.

Problems —

What power does the magnet possess that makes it useful? (See page 174.)

How does the steam engine work? (See page 174.)

How does an aeroplane differ from a dirigible balloon?

How does the compass work? (See page 177.)

IV. Winter Sports.

1. Coasting.

A. Formation of snow, action of gravity on sled, increase in speed, other illustrations of action of gravity.

Problems —

How many different kinds of sleds are there?

Under what conditions does snow fall?

What other illustrations of the action of gravity can you think of?

V. Sky Studies.

1. The sun. (See page 187.)

A. Its size, distance, motions, relation to earth.

B. Observations on its change in position at sunrise, noon, and sunset; and on the change of time of sunrise and sunset.

Problems —

In what ways is the sun different from the earth?

What things that we do are influenced by the sun?

Spring

I. The Awakening Life of Spring.

1. Trees.

A. Study of twigs of nut trees.

B. Watch development of twigs kept in water indoors.

C. Watch development of buds out of doors; keep record of dates when buds open.

Problems —

How can we identify each of these trees before the buds open?

What is there in the buds that develops into leaves and flowers?

2. Wild flowers.

A. Brightly colored flowers, such as pasque flower, hepatica, wild ginger, bellwort, wild phlox, Jack-in-the-pulpit.

Problems —

Which do you like better the hepatica or wild ginger?

What makes the Jack-in-the-pulpit an interesting flower?

How can we tell the bellwort from other flowers?
Of what use are the different parts of the phlox flower?

3. Cultivated flowers.
   A. Calendar of garden flowers.
   B. Study of flowers growing from bulbs.

Problems —
Which do you like the best of the flowers that grow from bulbs?
What has been done to raise these flowers?

II. The Returning Life of Spring.

1. Birds.
   A. Calendar. (See page 52.)
   B. Changes in bird activities as the season advances.
   C. Special study of the birds of dooryards and shade trees; such as blue jay, English sparrow, robin, bluebird, chipping sparrow, house wren, Baltimore oriole, yellow warbler.
   D. Building nesting-houses for the wrens.
   E. Fountains for drinking and bathing.
   F. Formation of Audubon Bird Club; meetings during term.

Problems —
What changes do you notice in bird activities as the season advances?
Is the English sparrow a nuisance or of value to us?
Of what use is the robin to us?
How is the oriole fitted for its life in the air and among the trees?
How can you tell the yellow warbler from the goldfinch?

What kind of a house shall we make so as to get a pair of wrens to nest in it? (See page 65.)

How can we provide water for the birds during the summer?

Why would you like to form a bird club?

III. Gardening. Main topic: hardy annual flowers, and vegetables whose roots are eaten.

1. Schoolroom gardening.

A. Early in the season plant indoors a few flower seeds and vegetable seeds from the lists given below so that later the seedlings may be transplanted in the home or school gardens.

a. Seeds of some of the hardy annual flowers, such as sweet alyssum, bachelor's button, calliopsis, candytuft, nasturtium, California poppy, petunia, sunflower, zinnia.

b. Seeds of some of the vegetables whose roots are eaten, such as beet, carrot, celeriac, kohlrabi, oyster plant, parsnip, turnip.

Problem —

How can we have early flowers and vegetables in our gardens?

B. Germination experiments. (See page 131.)

a. Conditions for germination.

b. Depth of planting.

c. Testing vitality.

d. How squash seedling gets out of seed coat.

e. What happens to cotyledons.

f. How seedlings break through the soil.

g. Use of cotyledons to seedlings.

h. To show the expansive power of germinating seeds.

2. Home Gardens.

A. Distribute order envelopes for penny packets of seeds.

B. Encourage the children to plant some of the seeds mentioned above.

a. Lessons on the preparation of soil, the planting of these seeds, and the subsequent care which these groups of plants require.

Problems —

Why would you like to have a garden at home?

How can root vegetables be raised?

How can the hardy annual flowers be raised?

How should the soil of the garden be prepared before planting seeds?

SEASONAL ORDER OF TOPICS

March	*April*	*May*
Give out seed envelopes	Robin	Calendar of garden flowers
Twigs of trees	Bluebird	Wren
Plant seeds in room or cold frame	How plants use water	Later spring flowers
Start bird calendar	Lessons on home garden	Oriole
Blue jay	First spring flowers	Bird fountains
English sparrow	Chipping sparrow	Flowers from bulbs
Form bird club	House for wren	Yellow warbler

FIFTH GRADE

Autumn

I. Garden Studies.

1. Report on summer experiences in the garden.

2. Cultivated flowers — tender annuals; such as aster, balsam, calendula, cosmos, four-o'clock, marigold, portulaca, velvet flower. Effect of frost on flowers.

Problems —

Which would you prefer to have in your garden, marigold or cosmos? (See page 120.)

How may each of these flowers be identified?

Why is the velvet flower a desirable flower to have in our gardens?

What garden flowers were not killed by the first heavy frost?

3. Planting bulbs.

A. For outdoor blooming; lilies and early spring flowers, such as crocus, glory of the snow, snowdrop, blue bells. Plant in school garden and encourage children to plant at home.

B. For indoor blooming during the winter — lily-of-the-valley or crocus. (See page 126.)

Problems —

How can we have early flowers next spring?

How can we have flowers in the schoolroom next winter?

4. House plants.

Problems —

What plants will do well indoors?

What care do these plants require?

5. Vegetables whose fruit or seeds are eaten; such as tomato, egg plant, corn, peas, beans.

Problems —

How are these vegetables raised?

How can these be kept for winter use?

Which of these make the best food?

Which can be raised most easily in a small garden?

What are the parts of a corn plant that help grow the ear of corn? (See page 120.)

II. Plants in Nature's Garden.

1. Flowers that grow in open, sunny places; such as asters, clovers, daisies, goldenrods, wild sunflowers, toadflax, thistles.

Problems —

How many different kinds of goldenrods can you find?

In what ways is the wild aster like the cultivated aster?

How is the toadflax made so as to bring about insect pollination?

How can we tell the kinds of clovers apart?

2. Plants without flowers.

A. Ferns — both wild and cultivated.

Problems —

How do the various ferns differ from each other? (See page 108.)

What care do ferns as house plants require?

3. Shade trees of the locality; such as maples, elms, lindens, catalpa, box-elder, hackberry, honey locust, white poplar.

A. Work of the parts of a tree; root, stem, leaf. (See page 132.)

Problems —

Which is the best shade tree in our locality?

Arrange the shade trees in the order of their occurrence on the streets that you are familiar with.

What care do shade trees require?

How can we tell the different maples apart?

What is the chief character by which each tree may be named?

What work is done by the root of a maple tree? By the stem? By the leaf?

4. Calendar of leaf coloring of trees, shrubs, and vines. (See page 92.)
5. Plants that move.
   A. Sensitive plant, white clover, mallow, sunflower, geranium.

Problems —

What kind of movements do the leaves and flowers of some plants have?

What causes these movements?

III. Some Animal Friends and Foes.

1. Spiders; orb weaver, grass spider, cobweb spider; value, web spinning habits.
2. Water insects, such as whirligig beetle, water strider, water boatman, backswimmer, water beetles, nymph of dragon fly; caddis worm; methods of moving and breathing.
3. Housefly, relation to disease.
4. Crayfish, habits, value.
5. Compare bird life now with that in spring.
6. Feeding winter birds.

Problems —

How is the web of an orb weaver made? (See page 80.)

How do spiders' webs differ from each other?

Are spiders harmful or helpful?

How is the caddis worm adapted for living in the water?

How do some insects live on the surface of water? (See page 77.)

How are certain insects fitted for living in the water?

What harm is done by the house fly?

What can be done to get rid of the fly?

What habits of the crayfish may be observed from a study of a crayfish kept in the schoolroom?

How do the activities of birds now differ from their activities last spring?

How may we help the winter birds? (See page 65.)

IV. Some Plant Foes.

1. Poisonous plants, such as poison ivy, Jimson weed, pokeweed, poisonous mushrooms; identification, nature of injury, remedies.

Problems —

How may we know the poison ivy when we see it? (See page 138.)

What harm does each plant do?

What is to be done in case of poisoning with any of these plants?

V. Aquarium Studies.

1. Scavengers — tadpole and snail.

Problems —

Of what use are tadpoles and snails in the aquarium?

How does the snail's way of living in the water differ from the fish's way?

VI. Fall Sports.

1. Giant stride; other illustrations of centrifugal force such as cream separator, clothes-drier, fly-wheel, sling.
2. Teeter; other applications of the lever such as crowbar, hammer, pump handle, pantograph, scales for weighing. (See page 180.)
3. Value of exercise to the body; muscles of the body.

Problems —

What principles that are illustrated in the giant stride are applied elsewhere?

How do the various applications of the lever differ from that found in the teeter?

In what way is the exercise on these pieces of apparatus good for the muscles of the body?

SEASONAL ORDER OF TOPICS

September	*October*	*November*
Wild flowers	Ferns	Water insects
Tender annuals	Spiders	Crayfish
Start calendar of leaf coloring	Bulbs — out of doors	Vegetables
	Compare bird life with spring	Feeding birds
House plants		Bulbs — indoors
House fly	Trees	Tadpole and snail
		Stride and teeter

Winter

I. Plants and Animals in Winter.

1. Winter decorations — flower of lily-of-the-valley or crocus.

Problem —

Which do you think adds more to the appearance of the room, a flower like the lily-of-the-valley or a foliage plant like the fern?

2. Tree studies.

A. Bark of trees.

B. Uses of trees and forests while standing.

C. Uses of the wood after the tree is cut down.

Problems —

How do the barks of trees differ?

Of what use are trees while standing?

What uses are made of the wood after the tree is cut down. (See page 96.)

How may we tell the trees apart in winter?

3. Winter birds; such as blue jay, English sparrow, nuthatch, chickadee, woodpecker; identification, feeding.

Problems —

What is the best way of telling the winter birds apart?

How can we help them in winter? (See page 65.)

4. How animals spend the winter.

Problem —

In what different ways do wild animals spend the winter?

II. Health Studies.

1. Drinks.

A. Drinks that are harmful to children; tea, coffee, alcoholic drinks, patent medicines.

B. Drinks that are good for children.

a. Milk; its sources, uses, methods of keeping sweet and clean, products made from milk.

b. Water; use to the body, how it becomes unfit to drink, how made pure, public drinking cup and sanitary fountain; method by which rain forms.

Problems —

Why are patent medicines not good for sick people to use?

Why should not children use tea, coffee, or alcoholic drinks?

What makes milk such a good drink for children?

What care needs to be taken to be sure that our drinking water is clean?

2. Foods.

A. What children eat in other lands.

B. Comparison of food of animals with food of man.

Problems —

How does the food that children in other countries eat differ from the food you eat?

How does the food of animals differ from that of man?

3. Breathing. (See page 159.)

A. How done, need of, frequency, lungs, lung capacity, breathing through mouth and nostrils, artificial breathing in case of apparent drowning and gas suffocation.

B. Composition of air, effect on air of breathing, amount of air breathed.

C. Effect on breathing of tight clothing, and of exercise.

Problems —

What takes place in our lungs while we are breathing?

What are some of the things that interfere with proper breathing?

4. Clothing.

A. Purposes, dependence on season, how children in other lands are clothed.

B. Animal coverings; hair, wool, fur, feathers, scales, skin, shell, silk.

C. Ability of clothing material to conduct heat.

Problems —

How does the clothing of children in other lands differ from your clothing?

What health factors should determine the kind of clothing we wear?

What different kinds of coverings do animals have?

5. Care of skin.

A. Bathing, kinds of baths, swimming.

Problems —

Of what value are the different kinds of baths?

What are the strokes commonly used in swimming?

III. Winter Pleasures.

1. Outdoor sports; skating, formation of ice; floating of ice; value to body of outdoor exercise.
2. Evening entertainments. (See page 181.)
   A. Stereopticon, moving pictures, phonograph, talking movies.

Problems —

How many kinds of skates are there?

How does ice form?

How does a moving-picture machine differ from a stereopticon?

How does the phonograph reproduce sounds?

What advantages have the talking movies over the phonograph or moving pictures alone?

IV. Sky Studies.

1. The moon; its size, distance, motions, relation to earth.
   A. Observations on its phases, changes in position in sky; and changes in time of rising and setting. (See page 188.)

Problems —

What effect does the moon have on man's life?

In what ways is the moon different from the sun?

Spring

I. The Awakening Life of Spring.

1. Trees.
   A. Leaf calendar. (See page 92.)

B. Special study of shade trees of vicinity. Watch development of twigs kept in water indoors.

C. Flowers of maple and elm.

Problems —

What is the order in which the buds of our shade trees open?

How can we identify our shade trees before the buds open?

What is there in the bud that develops into leaf and flower?

How do the flowers of the elm and maple differ from other flowers that you know, such as the hepatica.

2. Wild flowers.

A. Calendar. (See page 100.)

B. Special study of white spring flowers, such as blood root, dwarf trillium, Dutchman's breeches, wild strawberry, toothwort.

Problems —

How does the flower of the bloodroot differ from the flower of Dutchman's breeches?

What is the best way of identifying each of these flowers?

How are these adapted to insect pollination?

Which do you like the better of any two of these flowers?

3. Cultivated flowers.

A. Study of spring flowering perennials such as columbine, iris, lily-of-the-valley, peony, bleeding-heart.

Problems —

Why are these desirable flowers to have in our garden?

What is it necessary to do in order to have these flowers?

II. The Returning Life of Spring.

1. The birds.

A. Special study of birds of the air; such as rough-winged swallow, bank swallow, martin, chimney swift, barn swallow, night hawk, humming bird.

B. Building nesting-houses for bluebird and wren.

C. Study of nesting habits.

a. Nest, location, materials, construction; eggs; number, size, color, incubation, young birds; care given by parents, time in nest; putting out nesting material.

D. Formation of Audubon Bird Clubs, meetings during term.

Problems —

In what ways are swallows fitted for living on the wing?

How can we tell the different swallows apart?

Of what use are the swallows to us?

What makes bird houses a better protection to the birds than their natural nesting sites?

How can we get some bird like the wren or bluebird to help us destroy the insects in our garden?

What materials do birds' nests contain that we can put out for the birds to use?

Where do birds build their nests?

What care do the parent birds give their young?

III. The New Life of Spring.

1. Development of frog's eggs.

Problem —

What changes take place during the development of the frog's eggs?

IV. Gardening. Main topic: tender annual flowers; and vegetables whose leaves are eaten.

1. Schoolroom gardening.

A. Early in the season plant indoors or in a cold frame a few seeds from each of the lists given below so that the seedlings may later be transplanted into the home or school gardens.

a. Plant seeds of some of the tender annuals; such as aster, balsam, cosmos, four-o'clock, marigold, portulaca, velvet flower.

b. Plant seeds of some of the vegetables whose leaves are eaten, such as cabbage, celery, Swiss chard, cress, endive, lettuce, parsley.

Problems —

How may we have early flowers and vegetables in our gardens?

How should seedlings be transplanted?

B. Work of roots (To be answered by experiments. (See page 132.)

a. Absorption of water.

b. Root hairs.

c. Direction of growth.

d. Food storage — carrot basket.

2. Home gardens.

A. Distribute order envelopes for penny packets of seeds.

B. Encourage children to plant some of the seeds mentioned above under A. Lessons

on the culture of tender annual flowers and of salad plants. Value of fresh vegetables for food.

C. Insects of the gardens.

Problems —

How can tender annual flowers be raised?

How can salad plants be raised?

Why do vegetables that we raise in our own gardens make good food?

What do insects do in the garden?

SEASONAL ORDER OF TOPICS

March	*April*	*May*
Give out seed envelopes	Organize Audubon Bird Club	Chimney swift
Twigs of trees	Lessons on home garden	Barn swallow
Plant seeds indoors	Start flower calendar	Later spring flowers
House for bluebird	Early flowers	Night hawk
Nests	Martin	Humming bird
How plants grow	House for wren	Cultivated flowers
Work of plants	Frog's eggs	Nesting habits
	Start leaf calendar	Insects of garden
	Bank swallow	
	Flowers of maple and elm	

SIXTH GRADE

Autumn

I. Garden studies.

1. Report on summer experiences in the garden.
2. Cultivated flowers — vines.

A. Annual vines such as balloon vine, canary bird flower, hyacinth bean, cypress vine, gourd, Japanese hop, moon flower, morning-glory, sweet pea.

B. Perennial vines such as bittersweet, clematis, Engelmann's ivy, Boston ivy, trumpet

honeysuckle, everlasting pea, wistaria, woodbine.

Problems —

Which are better vines to grow in our yards, annuals or perennials?

What support is needed for each kind of vine? (See page 104.)

What uses are made of vines?

Which of these vines is the prettiest in the fall when the leaves are coloring?

Which is the more desirable vine to grow, the morning glory or canary bird flower?

C. Flowers from spring bulbs; tuberose, gladiolus, dahlia.

Problem —

Which flower is better for decorating a yard, gladiolus or dahlia?

3. Planting bulbs.

A. For outdoor blooming. Plant in school garden and encourage children to plant at home.

a. Hyacinths (single, double, grape, feathered, wood, Spanish).

B. For indoor blooming. (See page 126.)

a. Roman hyacinth.

Problems —

What is the best way to plant fall bulbs?

How may we have flowers in our room next winter?

4. Vine crops; such as cucumber, melons, summer and winter squash, pumpkin, pollination of their blossoms; grapevine.

Problems —

How do the flowers of the pumpkin differ from each other?

Which of these fruits makes the best food?

How may some of these be stored for winter use?
In what respects are these fruits alike in structure?

5. Some common weeds of the garden; such as mallow, pigweed, lamb's quarters, purslane, quackgrass. Their identification and control. (See page 135.)

Problems —
What are the most common weeds that grow in the garden?
How may they be identified?
How may each of these weeds be controlled?

6. Fruit trees and their fruits.
   A. Apple, plum (both wild and cultivated), cherry (both wild and cultivated), pear, peach.

Problems —
How many different kinds of apples are there that grow around here?
How do the cultivated plum and cherry differ from the wild?
What harm is done to apple trees and apples by insects?
How may these insects be controlled?
How do varieties of apples differ from each other?

II. Plants in Nature's Garden.

1. Vines; such as bittersweet, climbing buckwheat, clematis, wild cucumber, wild morning glory, wild grape, poison ivy, wild peanut, moonseed, smilax, woodbine.
   A. Calendar of coloring and fall of leaves of vines, both wild and cultivated. (See page 92.)

Problems —
How may the wild vines be told apart?

Which of these vines have features which make them suitable for planting in the home grounds?

How do vines climb? (See page 104.)

2. Flowerless plants.

A. Mosses, lichens, and horsetail.

Problems —

How do mosses differ from lichens?

3. Tree fruits still hanging on trees; such as ash, catalpa, cones of evergreens, red cedar, coffee tree, hornbean, ironwood, box-elder, linden, locust, sugar maple. Dispersal of tree fruits.

Problems —

What trees may be identified by means of the fruit hanging on them?

How are these tree fruits adapted for dispersal?

4. Fruits that serve as food for the fall and winter birds; such as mountain ash, barberry, bittersweet, burning bush, hackberry, dogwood, smilax, snowberry, sumac, viburnum; identification of these shrubs from fruit and leaf.

Problems —

What kind of fruits do shrubs bear that birds like to eat?

How may these shrubs be identified?

III. Some Friends and Foes of the Garden.

1. Insect friends and foes; such as potato beetle, white grub, cutworm, cabbage worm, corn ear worm, bees, lady beetles; harm or good done; remedies for injurious kinds.

Problems —

What harm have insects done to the garden during the past summer?

In what ways have insects been helpful?

2. Bird friends; fall migration of birds; nest census (after fall of leaves).

Problems —

How do the activities of birds now differ from their activities last spring?

Which are among the first birds to leave, and which stay the longest?

How many birds' nests can we find in the trees growing within two blocks of the schoolhouse?

3. Toad.

Problem —

What does the toad do for us?

IV. Aquarium Studies.

1. Water plants.

Problem —

How do plants that live in the water differ from those that live on land?

V. Fall Sports.

1. Bicycling, bicycle pump, compressed air.

Problems —

Which is the better bicycle, the kind with or without chains?

What is the difference in the different makes of bicycles?

Seasonal Order of Topics

September	*October*	*November*
Flowers of spring bulbs	Weeds	Fruit trees
Flowers of vine crops	Vine crops	Plant bulb indoors
Annual cultivated vines	Garden insects	Tree fruits
Perennial cultivated vines	Mosses and lichens	Nest census
Wild vines	Plant bulbs out of doors	Fruits for birds
Start vine calendar	Fall migration of birds	Bicycling
Toad		Water plants

Winter

I. Plants and Animals in Winter.
   1. Winter decorations — flower of Roman hyacinth from bulb planted in fall.
   2. Tree studies.
      A. Buds of trees.
      B. Enemies of trees and forests.

   Problems —
   What makes the hyacinth a desirable flower to have in the room?
   What trees can we name through the difference in their buds?
   What are the chief enemies of trees?

   3. How plants spend the winter.
   4. Winter birds.
      A. Value of birds.
      B. Helping our bird friends by feeding them.

   Problems —
   What do birds do for us?
   How can we help the winter birds? (See page 65.)

II. Health Studies; keeping the body well and strong.
   1. Foods.
      A. Cooking, needs, ways.
      B. Preservation of foods; in ice chest, cellar, by canning, drying, salting.
      C. Difference in food according to seasons.
      D. Compare food of plants with food of animals.
      E. Digestion of foods, solubility, use by body.

   Problems —
   How does cooking make foods better?
   In what ways may foods be kept from spoiling?
   How does our food change from season to season?

How does the way in which plants get their food differ from the way in which animals get their food?

What happens to our food after it is swallowed?

2. Heating and ventilation; how to get a supply of warm, fresh air. (See pages 159 and 162).
   - A. Ways of heating: fireplace, stove, hot-air furnace, hot water, steam.
   - B. Use of thermometer.
   - C. Composition of air.
   - D. Things that spoil pure air: tobacco smoke, lamps, gas jets and ranges, people, dust, bad odors from unclean objects, such as clothing, bodies, teeth, decaying food.
   - E. Effect of impure air on people.
   - F. How to get pure air in the sleeping-room, the home, and the schoolroom.
   - G. How the air in the room moves; drafts.
   - H. Amount of air needed.

Problems —

Which is the best method of heating our homes?

Which system of heating gives the best ventilation?

What are some of the things that spoil pure air?

How is our schoolroom ventilated?

How is your home ventilated?

How may we get fresh air in our sleeping-room?

How does the thermometer enable us to tell the temperature of our rooms?

3. Clothing; protecting the body.
   - A. Different kinds of materials used, sources, method of making clothing from each; shoes and rubbers.

Problems —

What kind of material makes the best clothing?

Through what changes does each kind pass from its source till it is made into clothing?

What points that effect health should be considered when buying shoes?

4. Avoiding infectious diseases.

A. Causes, relation of bacteria to disease, activities of bacteria.

B. Routes of transfer to well persons; food, water, flies, milk, contact (for nose and mouth discharge as in tuberculosis, through sputum, mouth-spray and hands).

C. Prevention: clean hands, care in depositing sputum, avoid throwing mouth-spray into people's faces, care of patients.

D. Special study of a few diseases, such as tuberculosis, typhoid fever, diphtheria, smallpox.

Problems —

What part do bacteria play in infectious diseases?

How may these bacteria be carried from sick to well persons?

What can we do to prevent our catching these diseases?

What can we do to prevent other people from catching diseases from us when we are sick?

5. The blood system; the errand boy of the body.

A. Uses of blood, heart, and blood vessels?

Problems —

What does the blood system do for the body?

What to do in case of accidents.

A. Cuts, burns, drowning, suffocation, poisoning.

Problems —

What may be done in case of poisoning?

In case of apparent drowning how may respiration be restored?

In case of cuts what may be done to stop bleeding?

What may be done to care for burns?

III. Christmas Studies.

1. Christmas trees and other evergreens.

Problems —

How can we identify the evergreens that grow around here?

What use is made of the wood of evergreen trees?

IV. Winter Sports.

1. Roller skating; going around curves, other illustrations of centrifugal force.

Problems —

How does roller skating differ from ice skating?

What other illustrations of centrifugal force can you think of?

V. Sky Studies.

1. The stars and planets; distances, size, relation to earth.
2. Observations on constellations, difference between winter and summer constellations, constellations visible at all seasons, how to find the north star. (See page 189).

Problems —

How are stars different from planets?

Which has the greatest effect on man, the moon, sun, planets, or stars?

Which the least effect?

VI. Some Simple Machines that make Man's Work Easier. (See page 180.)

1. Pulley, screw, wedge: common applications of each; compare lever and pulley; inclined plane and wedge.

Problems —

How does each of these machines work so as to enable man to lift heavy loads?

How many applications of each can you think of?

VII. How Glass helps People.

1. In reading — spectacles.
2. In seeing afar off — opera and field-glasses.
3. In taking pictures — camera; blue prints; developing, printing. (See page 178.)

Problems —

How do glasses help one to see better?

How do opera glasses seem to bring objects nearer?

In what ways is the camera like the human eye?

How can we make blue prints of leaves, or from some negative?

How many different kinds of cameras are there?

How are negatives developed?

What are the different ways of printing?

VIII. Helps in being Prompt.

1. Watches and clocks.
2. School electric bells.
3. Old methods of telling time; sundial, hour-glass.

Problems —

We will take an old alarm clock apart to see if we can understand how it keeps time.

How are our electric bells arranged so as to give the signals for the periods?

We will make an hour-glass and see if we can keep account of time by it. (See page 179.)

Spring

I. The Awakening Life of Spring.

1. Trees and shrubs.

A. Flower calendar of trees. Special study of tree flowers of common shade trees and fruit trees.

B. Special study of fruit trees and small fruits, such as apple, plum, cherry, peach, pear, strawberry, raspberry, blackberry, currant; pollination of fruit blossoms; wind pollinations; grapes.

C. Watch development of twigs of fruit trees kept indoors in water.

D. Insect enemies of fruits — the codling moth.

E. Methods of propagating fruits.

Problems —

How do the flowers of our shade trees differ from the flowers of fruit trees?

In what ways is the apple blossom adapted to bring about insect pollination? (See page 103.)

In what ways are the flowers of the plum and cherry alike?

How may we raise strawberries in our home gardens?

In how many ways do we use strawberries as food?

What are the methods of getting new apple trees?

What of getting new plants of grapes, currants, and other fruits?

In what ways do wind-pollinated flowers differ from insect-pollinated flowers?

2. Cultivated shrubs.
   A. Study of flowers of spring blooming shrubs, such as lilac, Juneberry, golden bell, flowering almond, snowball, weigela, bridal wreath.

Problems —

What makes each of these an attractive shrub to grow in our yards?

How can we tell them apart?

II. The Returning Life of Spring.
1. Birds.
   A. Special study of birds of the marsh, such as red-winged blackbird, kingfisher, bobolink, marsh wren; and of birds of meadows and fields, such as bobwhite, horned lark, goldfinch, meadowlark, song sparrow, vesper sparrow, field sparrow, flicker, cowbird, indigo bunting.
   B. Building open nesting-boxes for the robin and phœbe.
   C. Migration; times; groups of birds (permanent, summer, and winter residents, transient visitants); routes, distances, causes; calendar of spring migration.
   D. Bird enemies; bird protection. Special emphasis on the work of the Audubon Societies.
   E. Formation of Audubon Bird Club; meetings during term.

Problems —

What birds prefer to live near wet places?

Of what use are the birds of the meadows and fields to us?

Which is the most valuable of these birds?

What habits of these birds are specially interesting to us?

What kind of a nesting-box can we make so as to get a pair of robins or phœbes to nest in it?

How are birds grouped according to the time that they stay with us?

Let us try to follow on a map the travels of a bobolink for a year.

What are the chief enemies of birds?

What is the Audubon Society doing to protect birds? (See page 66.)

What can we in our Audubon Club do to protect birds?

What are our State and National Governments doing to protect birds? (See page 67.)

III. Gardening. Main topic; vines and vine crops.

1. Schoolroom gardening.

A. Early in the spring plant indoors or in a hotbed a few seeds from the lists given below so that the seedlings may later be transplanted to the home or school gardens.

a. Plant seeds of some of the annual vines such as balloon vine, hyacinth bean, canary bird flower, cypress vine, gourds, Japanese hop, moon flower, climbing nasturtium, morning glory, sweet peas.

b. Plant some seeds of the vine crops such as melons, pumpkin, cucumber, winter and summer squash.

c. Plant summer flowering bulbs such as tuberose, gladiolus, dahlia.

B. Work of leaf. (See page 134.)
   a. Transpiration.
   b. Light and starch-making.
   c. Leaf exposure to sunlight.
   d. Sleep movement of leaves.
   e. Effect of light on growth of stem and leaves.

Problems —

How may we have early flowers and vegetables in our gardens?

What is the difference between a cold frame and hotbed?

What effect do light, water, and gravity have on the direction in which the parts of a plant grow?

2. Home gardens.
   A. Distribute order envelopes for penny packets of seeds.
   B. Encourage the children to plant some seeds from the lists given above under A, and also bulbs.
   C. Lessons on the culture of vines and vine crops. Value to body of the outdoor exercise in gardening. Thinning plants.

Problems —

What are some of the best vines to plant?

How can these vines be raised?

In what ways is the care that the different vines crops require the same?

How may we raise some extra early cucumbers?

We will each make a plan on paper of our garden just as we would like to plant it.

3. Garden calendar; reports arranged in three columns as follows: garden activity observed, date, name of child first reporting.

IV. Spring Sports.

1. Outdoor toys, such as kite, windmill, water-wheel — types, undershot, overshot, turbine; natural and artificial waterfalls.

Problems —

In what ways is an aeroplane like a kite?

Which are more useful, windmills or water-wheels?

How does a windmill differ from a water-wheel in the way it is made?

What is the best way to make toy water-wheels and windmills?

SEASONAL ORDER OF TOPICS

March	*April*	*May*
Distribute seed envelopes	Start tree flower calendar	Indigo bunting
Twigs of trees	Red-winged blackbird	Flowers of fruit trees
Plant seeds indoors	Flowers of shade trees	Propagation of fruits
Plant activities	Lessons on home garden	Bobolink
Goldfinch	Start garden calendar	Marsh wren
Bobwhite	Song, vesper, field sparrows	Codling moth
Spring sports	Raising strawberries	Cultivated shrubs
Bird enemies	Kingfisher, cowbird, flicker	
Bird protection	Bird migration	
Form Audubon Bird Club		
Nesting-boxes for robin		

SEVENTH GRADE

Central thought for the grade: the hygiene and science of the home

Autumn

I. Making the Home Yard attractive.

1. Shrubs; cultivated, and wild shrubs adapted for planting in the yard.
2. Vines; cultivated, and wild vines adapted for planting in the yard.
3. Flower garden.

A. Perennials; identification of common kinds.

B. Annuals; identification of new kinds not already known.
C. Plant bulbs.

(In the fall, study shrubs, vines, and flowers for identification and to learn their decorative value.)

Problems —

How may our shrubs, vines, and flowers be identified?
What decorative value has each of these for growing in the home yard?
Which make better garden flowers, annuals or perennials?
What wild vines and shrubs are adapted for planting in the home yard?
Which are the best fall garden flowers?
What bulbs are best adapted to this climate?
How should they be planted?

II. Making the Yard useful.

1. The vegetable garden.
   A. Canning and storing vegetables.
   B. Garden insects.
   C. Garden weeds.
2. The fruit garden.
   A. Canning fruits.

Problems —

What are the best methods of storing vegetables for the winter? (See page 122.)
How does the method used in canning vegetables differ from that used for fruits?
How may fruits be canned? (See page 122.)
What harm are insects doing to the garden?
What are the most troublesome weeds found in the garden?

III. Growing Plants Indoors.
1. House plants; kinds, care, raising from cuttings. (See page 126.)

Problems —
What plants are best adapted for growing in the house?
What care do these plants require?

IV. Insect Pests of the Household.
1. Ants, cockroaches, carpet beetle, clothes moth.

Problems —
What harm does each of these pests do?
How may each be controlled?

V. Heating the Home. (See pages 162–164.)
1. Fireplace.
2. Stove.
3. Hot-air furnace.
4. Steam.
5. Hot water.
6. Fuels used; chemistry of burning.
7. Causes and effects of heat.

VI. Ventilating the Home. (See pages 159–162.)
1. Means for each of the above methods of heating.

Problems —
What are the essential differences between the hot air, hot water, and steam systems of heating?
From the standpoint of heating alone which is the best system?
From the standpoint of ventilation which is the best system?
How can the advantages of the various systems from the standpoints of both heating and ventilation be combined in one system?

If the home is heated by stoves, how may ventilation be secured? In what ways is the burning of fuel in the furnace similar to the burning of food in our bodies?

What effects of heat are illustrated in these various methods of heating? (See page 163.)

SEASONAL ORDER OF TOPICS

September	*October*	*November*
Flowers	Canning fruits and vegetables	Heating the home
Shrubs	Storing vegetables	Ventilating the home
Vines	Insects	
	House plants	

Winter

I. Lighting the Home. (See pages 170–171.)

1. Kerosene; capillarity in wick.
2. Gas; relation of heat and light.
3. Electricity.
4. Protection from fire; fire extinguisher.

Problems —

What principles are involved in the working of the kerosene lamp?

What advantages has gas over kerosene?

What advantages has electricity over both gas and kerosene?

How do fire extinguishers work?

II. The Home Water Supply.

1. Springs; health considerations.
2. Wells; types — dug, driven, bored, drilled.
3. Cisterns; soft and hard water. (See page 183.)
4. Pumps; air pressure, the siphon. (See page 173.)
5. Hot-water tanks.

6. Pneumatic water system; tank, pump, engine, windmill.
7. City water supply; source; pressure.
8. Ice; source, purity, methods of using; the ice chest; freezing ice cream. (See page 173.)

Problems —

What care should be taken to keep the water of wells and springs clean?

What are the differences between hard and soft water?

How is the lift pump constructed?

How may the country home have a supply of running water?

How is our city supplied with water?

What considerations of health should be taken into account in the use of ice?

III. The Food Supply.

1. Need of food.
2. Combinations of foods needed.
3. Economy of food selection.
4. Preservation and protection of foods.
5. Cooking foods.
   - A. Reasons for cooking.
   - B. Means of cooking; stove, gas, electricity, fireless cooker.
   - C. Chemistry of cooking. (See page 164.)
     - *a.* Experiments to show effects of heat on proteins, fats, and starches; tests for proteins, fats, starches, and minerals; study of chief elements found in foods, — N.O.C.P.S.H.; tests for acids and bases; action of yeast and baking powder.

Problems —

Why does the body need foods?

How may one know what combinations of foods to select?

To what extent may economy be taken into account without injury to health?

What care should be taken to keep foods sweet and clean?

Which is the best means of cooking, by the stove, the gas range or electricity?

How is the fireless cooker constructed?

IV. Entertainment in the home: musical instruments.

1. Phonograph.
2. Piano.
3. Violin, guitar, and other stringed instruments.
4. Causes of sound; physical cause of musical sounds.

Problems —

How is the phonograph constructed?

What are the principles involved in the making and using of records?

In the piano, violin, and other stringed instruments how is the pitch controlled? (See page 181.)

What makes the difference in the quality of the tones of these stringed instruments?

V. The Electric Doorbell; constructions, batteries.

Problem —

How does the electric bell work?

Spring

I. Making the Yard attractive.

1. Shrubs and vines; selection of kinds; kinds to attract birds; arrangement; method of planting.

2. Flower garden; location; planning; selection of flowers for harmony of colors; physical explanation of color, the spectrum and rainbow; preparation of soil; planting seeds; subsequent care.
   A. Annuals; plant seeds.
   B. Perennials. Plant seeds or set out roots.
   C. Bulbs — study flowers.

      (While in the fall the chief thought was the study of the plants themselves, in the spring the chief thought is the planting of seeds and plants.)

3. Wild-flower garden.

Problems —

What shrubs and vines are best adapted to this climate?

How should shrubs be arranged to secure the most artistic effects?

What points should be taken into account in planning a flower garden?

What is the physical explanation of the difference in color of flowers?

How do annuals and perennials differ in the care needed to raise them?

What decorative value have the flowers of the bulbous plants?

What makes the tulip a desirable garden flower?

II. Making the Yard useful.

1. The vegetable garden. Financial returns; plan, selection of varieties, preparation of soils, tools, hotbed and cold frame, planting; care.

Problems —

What financial returns may be expected from a small vegetable garden?

What considerations that apply to the planting and care of the flower garden apply also to the vegetable garden?

To what extent is the consideration of varieties important?

What advantages has the wheel-hoe?

How may early vegetables be raised?

What is the difference between the hotbed and cold frame?

2. The fruit garden. Classification of fruits, propagation, comparison with vegetable garden; dwarf fruits.

   A. Strawberries; varieties, fall bearing, methods of planting, care the first, second, and third seasons; financial returns.

   B. Grapes; raspberries and other bush fruits.

   C. Work of the stem of fruit plants.

      a. Passage of liquid up stem. (See page 133.)

      b. Passage of liquid down stem.

      c. Direction of growth.

Problems—

Which is the best method of setting out strawberries?

How may strawberries be obtained in the fall of the same year the plants are set?

How does the care of the strawberry for the first season differ from the care the second and third seasons?

How does the method of raising raspberries differ from the method of raising strawberries?

How do fruit growers get new plants of strawberries, raspberries, and currants?

How do dwarf fruits differ from the ordinary kinds?

3. Poultry-keeping.
   A. Financial returns; varieties, housing, feeding, hatching eggs, rearing chicks.

Problems —
- What are the interesting things about poultry-keeping?
- What conditions must a good house meet?
- How should poultry be fed?
- Which is the better method of hatching eggs, by incubator or hen?

4. Bee-keeping.
   A. Financial returns; kinds of bees, life of the hive, swarming, wintering.

Problems —
- What advantage does bee-keeping have over poultry-keeping?
- What disadvantages?
- What care should be given bees during the swarming season?
- How should bees be wintered in this climate?
- Which offers better opportunities for financial returns, bee-keeping or poultry-keeping?

III. Enemies of the Garden.

1. Insects; such as cutworm, cucumber beetle, potato beetle, squash bug, corn-ear worm, white grub.

Problems —
- What harm is done by each of these insects?
- What is the remedy for each?
- Through what changes does the potato beetle pass in its growth?

IV. Friends of the Garden.

1. Birds.
   A. Birds of the garden and orchard, such as chickadee, cuckoo, kingbird, nuthatch,

phœbe, wood thrush, woodpeckers, grosbeak, robin, wren, bluebird, Baltimore oriole.

B. Attracting bird friends to the yard and garden by providing nesting-boxes, fountains, and planting shrubs to furnish fruit.

C. Bird songs: how made (syrinx); time of day and season given; differences; reproduction on musical scale.

D. Plumage of birds; moulting; differences in color according to age, sex, and season.

Problems —

Which is greater, the good or harm that the robin does?

Why is it desirable to have birds around the yard and garden?

How may each of these birds be identified?

Which is the most interesting bird?

In what ways is the wren (or any other bird) useful?

What may be done to increase the number of birds around our homes?

Which birds have the most musical songs?

How can we identify birds from their songs?

Through what changes in plumage does a rose-breasted grosbeak pass from the time it is first hatched till it is two years old?

2. The toad.

Problems —

Of what use is the toad in the garden?

What may be done to increase the number in our gardens?

3. Insects; such as lady beetle, ground beetle, aphis lion, dragon fly, ichneumon fly, bees, tiger beetle.

Problems —

In what ways is the lady beetle beneficial?
Which do you consider the most helpful?
How are dragon flies and damsel flies beneficial?

V. Soils of the Garden.

1. Kinds, composition, origin, water capacity, capillarity, fertilizing, cultivation, effect of earthworms on soil.

Problems (to be answered by experiments) —

What is the value of cultivating the garden besides killing the weeds?
How do roots get water from the soil in a dry season?
What kind of soil is best for furnishing water to plants during a dry season.
What kind of soil holds the most water after a rain?
Which is better for raising early vegetables, a sandy or clayey soil?
What effect does drainage of a wet soil have on the growth of plants?
Of what is soil composed?
How may the test for acid soil be made?
How are earthworms beneficial animals?

SEASONAL ORDER OF TOPICS

March	*April*	*May*
Soils	Shrubs and vines	Bee-keeping
Poultry-keeping	Shrubs for birds	Enemies of garden
Nesting-houses for birds	Fruit garden	Friends of garden
Plumage of birds	Vegetable garden	Bird songs
	Flower garden	Flowers from bulbs
		Bird fountains

EIGHTH GRADE

Central thought for the grade: the sanitation and science of community life

Autumn

I. Insects that Threaten Health.

1. Fly and mosquito. (See page 77.)

Problems —

What harm is done by each of these insects?

What are the remedies to be used in each case?

Which is the more dangerous insect in our locality?

Through what changes does each pass in its development?

What may be done to get rid of the mosquito? (See page 77.)

II. Insects in Relation to Growing Crops.

1. Insect foes.

A. Insect enemies of the vegetable garden.

B. Insect enemies of the orchard.

C. Insect enemies of cereal crops.

D. Insect enemies of shade trees.

E. Means of control; poisons used.

Problems —

What harm is done by each of these groups of insects?

What are the remedies?

How do the various remedies used differ in their method of operation?

2. Insects friends.

A. Those that destroy injurious insects.

a. Parasitic insects.

b. Predacious insects.

B. Insects that pollinate flowers.

Problems —

In what ways is each group of insects beneficial?

How do parasitic insects differ from predacious in their method of destroying insects?

Which is greater the good or harm that insects do?

In what ways are bees beneficial, besides making honey?

III. Plant Enemies of Crops.

1. Weeds; of vacant lots, of roadsides, of crops; harm done, identification, control, State laws.
2. Fungous diseases.

Problems —

In what ways are weeds harmful?

What are the most common weeds found growing by roadsides and in vacant lots?

How may each of these weeds be identified?

How may the rough pigweed and lamb's quarters be told apart? (See pages 139.)

In what ways is the foxtail harmful?

What weed seeds are found mixed with grains?

What characteristics do weeds possess that make them so troublesome?

What adaptations do weeds have for the dispersal of their seeds?

How many seeds may a single plant produce? (See page 139.)

What are the best means to use to control quack-grass?

In what ways may fungi injure plants?

IV. Forest Trees.

1. Study of trees found around our town which may grow elsewhere in forests.

Problems —

How may the different species of trees in the following groups be identified; oaks, ashes, maples, elms, evergreens?

How are the fruits of trees adapted for seed-dispersal?

What references are found to trees in literature?

V. Means of Travel.

1. On land. (See page 174.)

A. Steam cars — the steam engine.

B. Street cars — the motor.

C. Automobile — the gasoline engine.

D. The motor cycle.

Problems —

How does the steam engine work?

How does the gasoline engine differ from the steam engine?

How is the motor constructed?

Which is the more useful, the steam engine, the motor, or the gasoline engine?

2. On water. (See page 176.)

A. Steamboats, sail-boats, submarines; Archimedes principle.

B. The compass; the gyroscope.

Problems —

How is the modern steamboat constructed?

How does one manage a small sail-boat?

Why is the gyroscope sometimes used on ships instead of the compass?

We will perform some simple experiments to learn why a canoe or boat floats when it is loaded.

3. In air.

A. Airplanes; use of barometer to tell height.

B. Balloons — common and dirigible.

Problems —

What are the differences between the airplanes and the dirigible balloon?

Which offers the greater possibilities of usefulness?

How can the airman tell how high he is?

In what way is a balloon in the air like a boat on water?

VI. Means of Communication.

1. The telephone.
2. The telegraph — both common and wireless.

Problems —

How are the telephone and telegraph constructed?

Which is the more useful?

How does the wireless differ from the ordinary telegraph?

SEASONAL ORDER OF TOPICS

September	*October*	*November*
Fly and mosquito	Weeds	Means of travel
Insect foes of crops	Forest trees	Means of communication
Insect friends of crops		

Winter

I. Public Health and Sanitation.

1. Board of health — its duties and ordinances.
2. Milk supply — inspection needed.
3. Protection of food supply.
4. City water supply; water pressure.
5. Control of fly nuisance.
6. Treatment of contagious diseases; quarantine, vaccination.
7. Sewage disposal and removal of garbage; oxidation.

8. Playgrounds and parks.
9. Fire protection; fire engines.
10. Care of streets.
11. Lighting the streets — the dynamo.

Problems —

What are the duties of the Board of Health of our city?

What ordinances have they had passed to protect our health?

What can each of us do to help the Board of Health in its work to protect the public health?

What inspection is given our milk supply?

What is done to keep our meats, bread, pastry, fruits, and vegetables clean?

What is done to guard our water supply?

What is done when a case of contagious disease is found?

How are the sewage and garbage disposed of?

How does our city compare with other cities in its parks and playgrounds?

How are we protected from fires?

How are fire engines constructed?

What care is given our streets?

What are the chief things that still need to be done in our city to further protect our health?

II. School hygiene.

1. Ventilating and heating.
2. Lighting.
3. Drinking fountains.
4. Playgrounds.
5. Medical inspection.

Problems —

How is our building heated and ventilated?

Why should the public drinking cup be abolished?

What is being done in other cities in the medical inspection of schools.

What is being done in our city?

What further could be done along this line?

Spring

I. Forestry.

1. Uses of forests.
2. Decrease of forests.
3. Enemies of forests.
4. Proper methods of handling our forests.
5. Need and method of saving our forests.
6. State and national reservations.
7. The Bureau of Forestry of the Department of Agriculture.
8. Tree planting on prairies.
9. Work of the parts of a tree — root, stem, leaf.
10. Structure and uses of wood.

Problems —

Of what use are forests while standing?

What are the chief enemies of forests?

How may forest fires be controlled?

What is the proper way to care for forests?

What national reservations has the Government made?

What is being done by the National Bureau of Forestry to care for our national forests? (See page 97.)

To what extent may trees be planted on the prairies?

What work is done by the roots, stem, and leaves of the tree?

How does the appearance of the cuts of different woods differ?

How does the appearance of different cuts of the same wood differ?

II. Bird Friends of our Trees and Forests.

1. Special study of the birds of the woods, such as warblers, thrushes, woodpeckers, vireos.
2. Economic value of birds to the forests in destroying injurious insects; value elsewhere in destroying also weed seeds and rodents. Hawks and owls.
3. Bird enemies; shooting, millinery, cats, English sparrow, natural enemies.
4. Work of National Government to protect birds.
   A. Laws protecting migratory birds.
   B. Tariff restrictions on feathers.
   C. Bird reservations.
   D. Work of Bureau of Biological Survey.
5. Adaptations shown in bill, feet, tail, and wing.
6. Game birds; State and national laws.

Problems —

In what ways are birds useful to the forest?

In what other ways are birds useful?

How may we identify the different species of the following bird families: warblers, vireos, woodpeckers, thrushes?

What interesting habits of these birds may we study this spring?

Which have done more harm to the birds, man or the bird's natural enemies?

What is the National Government doing to protect birds? (See page 68.)

How can we help in this work of protecting the birds?

How do water birds differ from land birds in the structure and use of their feet, bill, wings, and tail?

Should hawks and owls be protected? (See page 67.)

SEASONAL ORDER OF TOPICS

March	*April*	*May*
Forestry	Forestry	Birds
	Birds	

BIBLIOGRAPHY

BIBLIOGRAPHY

General Nature-Study

Comstock, A. B. *Handbook of Nature-Study.* Comstock Publishing Company, Ithaca, New York.

Coulter, J. M. and J. G., and Patterson, A. J. *Practical Nature-Study.* D. Appleton & Company, New York City.

Hodge, C. F. *Nature-Study and Life.* Ginn & Company, Boston.

Holtz, F. L. *Nature-Study.* Charles Scribner's Sons, New York City.

Nature-Study Review. A magazine published monthly, excepting June, July, and August. Ithaca, New York.

Birds

Bailey, F. A. *Handbook of Birds of the Western United States.* Houghton Mifflin Company, Boston.

Baynes, E. H. *Wild Bird Guests.* E. P. Dutton & Company, New York City.

Blanchan, N. *How to Attract Birds.* Doubleday, Page & Company. New York City.

Chapman, F. M. *Handbook of Birds of Eastern North America.* D. Appleton & Company, New York City.

Forbush, E. H. *Useful Birds and Their Protection.* Massachusetts State Board of Agriculture, Boston.

Hoffman, R. *A Guide to the Birds of New England and Eastern New York.* Houghton Mifflin Company, Boston.

Reed, C. A. *Bird Guide to the Land Birds.* Doubleday, Page & Company, New York City.

Trafton, G. H. *Bird Friends.* Houghton Mifflin Company, Boston.

Trafton, G. H. *Methods of Attracting Birds,* Houghton Mifflin Company, Boston.

Bird-Lore. A magazine published bimonthly. Harrisburg, Pennsylvania.

Insects

Comstock, A. B. *Ways of the Six-Footed.* Ginn & Company, Boston.

Comstock, J. H. *How to Know the Butterflies.* D. Appleton & Company, New York City.

Comstock, J. H. *Insect Life.* D. Appleton & Company, New York City.

Doane, R. W. *Insects and Disease.* Henry Holt & Company, New York City.

McCook, H. C. *Nature's Craftsmen.* Harper & Bros., New York City.

Miller, M. R. *The Brook Book.* Doubleday, Page & Company, New York City.

O'Kane, W. C. *Injurious Insects.* The Macmillan Company, New York City.

Weed, C. M. *Farm Friends and Farm Foes.* D. C. Heath & Company, Boston.

Pets

Comstock, A. B. *The Pet Book.* Comstock Publishing Company, Ithaca, New York.

Trees

Blakeslee, A. F., and Jarvis, C. D. *Trees in Winter.* The Macmillan Company, New York City.

Keeler, H. L. *Our Native Trees.* Charles Scribner's Sons, New York City.

Roth, F. *First Book of Forestry.* Ginn & Company, Boston.

Schauffler, R. H. *Arbor Day.* Moffat, Yard & Company, New York City.

Stone, G. L., and Fickett, M. G. *Trees in Prose and Poetry.* Ginn & Company, Boston.

Flowers

Dana, W. S. *How to Know the Wild Flowers.* Charles Scribner's Sons, New York City.

Keeler, H. L. *Our Garden Flowers.* Charles Scribner's Sons, New York City.

Reed, C. A. *Wild Flowers East of the Rockies.* Doubleday, Page & Company, New York City.

Flowerless Plants

Atkinson, G. F. *Mushrooms Edible and Poisonous.* Henry Holt & Company, New York City.

Parsons, F. T. *How to Know the Ferns.* Charles Scribner's Sons, New York City.

Gardening

Bailey, L. H. *Manual of Gardening.* The Macmillan Company, New York City.

Dorner, H. B. *Window Gardening.* Bobbs-Merrill Company, Indianapolis, Indiana.

Maynard, S. T. *The Small Country Place.* J. P. Lippincott Company. Philadelphia.

Weeds

Georgia, A. E. *Manual of Weeds.* The Macmillan Company, New York City.

Weed, C. M. *Farm Friends and Farm Foes.* D. C. Heath & Company, Boston.

Hygiene

Ayres, Williams, and Wood. *Healthful Schools.* Houghton Mifflin Company, Boston.

Coleman, W. M. *The People's Health.* The Macmillan Company, New York City.

Dresslar, F. B. *School Hygiene,* The Macmillan Company, New York City.

Fisher, I., and Fisk, E. L. *How to Live.* Funk & Wagnalls, New York City.

Rapeer, L. W. *Educational Hygiene.* Charles Scribner's Sons, New York City.

Terman, L. M. *The Hygiene of the School Child.* Houghton Mifflin Company, Boston.

Physical Nature-Study

Coulter, J. M. and J. G., and Patterson, A. J. *Practical Nature-Study.* D. Appleton & Company, New York City.

Cummings, H. H. *Nature Study for Primary Grades.* American Book Company, New York City.

Cummings, H. H. *Nature-Study for Lower Grammar Grades.* American Book Company, New York City.

Cummings, H. H. *Nature-Study for Higher Grammar Grades.* American Book Company, New York City.

Rowell, P. E. *Science for the Fifth Grade.* Marine Journal Press, San Rafael, California.

INDEX

INDEX

Accidents, 256.
Aims of science teaching, 10.
Air:
  composition of, 159;
  fresh, 173, 215, 224, 232;
  pressure of, 159.
Apple blossoms, lesson plan on, 103.
Application of lesson, 40.
Applications of science, 6.
Aquarium studies, 230, 241, 253.
Arbor day, 93.
Arithmetic and bird study, 52.
Arithmetic and insect study, 72.
Art and science, 23.
Attracting birds:
  nesting-boxes, 218, 227, 235, 260;
  feeding, 22, 240;
  fountains, 235;
  shrubs, 272.
Audubon Association, 50, 55;
  lesson plan on, 66.

Bacteria, 256.
Baking powders, 165.
Bathing, 208, 215, 224, 244.
Bee-keeping, 271.
Bicycle, 253.
Birds:
  of the air, 247;
  of the fields, 260;
  of the marshes, 260;
  of shade trees, 235;
  migration, 260;
  nesting habits, 247;
  protection, 280;
  songs, 272.
Bird study:
  motivation of, 49;
  materials for, 50.
Bluebird, lesson plan on, 64.
Blue prints, 91.
Boat, 176.
Breathing, 159, 244.
Bulbs, 126, 206, 213, 221, 228.

Calendars:
  bird, 52, 211, 218, 226;
  flower, 100, 235, 246;
  garden, 126, 262;
  insect, 72.
Camera, 178.
Candle, 170.
Canning fruits, lesson plan on, 122.
Cat, lesson plan on, 85.
Caterpillars, 207.
Chemistry of kitchen, 183.
Child and curriculum, 26.
Christmas tree, lesson plan on, 95.
Clock, 179.
Clothing, 208, 216, 224, 244, 255.
Clubs, bird, 55.
Coasting, 233.
Collections:
  of leaves, 90;
  of insects, 71;
  of weeds, 135.
Compass, 177.
Condensation, 172.
Corn, lesson plan on, 120.
Correlation, 22, 61, 72, 93, 137.
Cosmos, lesson plan on, 120.
Cow, lesson plan on, 86.

Development of lesson plan, 39.
Diseases, 256.
Dog, lesson plans on, 83–85.
Domesticated animals, 223.
Dramatization, 55.
Drinks, 216, 243.

Earthworm, 230.
Eggshell garden, 130.
Evaporation, 172.
Evening entertainments, 245.
Experiments with plants, 129.
Eye, 166.

Fats, test for, 165.
Ferns, 239.

Field trips, 18, 60.
Fish, 207, 230.
Flexner, Abraham, 8.
Flowers, cultivated, 205, 210, 212, 217, 219, 225;
  from bulbs, 235;
  hardy annuals, 228;
  tender annuals, 237;
  perennials, 246, 263;
  vines, 240.
Flowers, wild, 205, 210, 212, 217, 219, 225;
  colored spring, 234;
  white spring, 246;
  of shady places, 229;
  of sunny places, 239.
Fly, 79, 240, 274.
Foods, 164, 208, 224, 232, 243, 254.
Forest fires, lesson plan on, 97.
Forestry, 279.
Freezing, 172.
Fruits, 213, 220.

Galls, lesson plan on, 75.
Games:
  bird, 53;
  flower, 100;
  tree, 92.
Gardening, 248, 269, 270;
  home gardens, 113, 123, 210, 217, 226, 237.
Geography and science, 23.
Germination experiments, 131.
Goldenrod, lesson plan on, 102.
Grasshopper, lesson plan on, 74.
Gyroscope, 178.

Habits of health, 145.
Hawks and owls, lesson plan on, 67.
Heat:
  sources of, 162;
  effects of, 163.
Heating the home, 162, 255, 265.
Hour-glass, 179.
House plants, 126, 238, 265.
Humidity of air, 161.
Hygiene:
  essentials for teaching, 144;
  motivation of, 148;
  school, 278;
  textbooks in, 154.

Insects:
  activities, 75, 230;
  of the garden, 271;
  parasitic, 274;
  pests of household, 265;
  pollinators of flowers, 274;
  social, 230;
  water, 77, 240.
Insect study:
  motivation of, 69;
  materials for, 70.
Interest and learning, 32.
Interests, dormant, 33.
Ivy, poison, lesson plan on, 138.

Lady beetle, lesson plan on, 79.
Leaf, work of, 134, 262.
Leaves, lesson plan on, 95.
Lever, 180.
Lighting the home, 170, 223, 233, 266.

Magnet, 174.
Maple tree, 41, 96.
Marigold, lesson plan on, 120.
Materials:
  living, 17;
  preserved, 20;
  for flower study, 99;
  for insect study, 70;
  for tree study, 89.
Meters, 171, 174.
Moon, 188, 245.
Mosquito, 77, 220, 274.
Motivation, 26;
  of bird study, 49;
  of gardening, 116;
  of hygiene, 148;
  of insect study, 69;
  of tree study, 88.
Movies, 174.
Mushrooms, 107, 229.
Musical instruments, 268.

Nasturtium, lesson plan on, 119.
National Government, protecting:
  birds, 67;
  forests, 97.
Needs, present and future, 28.

Observation, 44.
Organization of outline, 193.

Pendulum, 231.
Pets, 82, 208, 215.
Phases of science, 3.
Physiology, temperance, 156.
Piano, 181.
Pictures, 20, 50.
Plan, lesson, 41–43.
Plane, inclined, 180.
Planting seeds, lesson plan on, 125.
Poisonous plants, 241.
Poultry-keeping, 271.
Problems, 30, 36, 37.
Propagation of house plants, 128.
Protein, test for, 165.
Public health, 277.
Pumping water, 173.

Roots, work of, 132.

Screw, 181.
Seasonal changes, 207, 211, 214, 218, 222.
Seed dispersal, lesson plans on, 105-07.
Seeds, 206, 207, 213.
Shrubs, 260, 263.
Skating, 245, 257.
Sky studies, 187, 257.
Slide, 231.
Soils, 273.
Spiders, 89, 240.
Squirrel, 230.
Starch, test for, 164.
Stars, 257.
Stem, work of, 133.
Storing vegetables, 122.
Submarine, 178.
Sun, 187, 234.
Swing, 231.

Teeter, 241.
Telegraph, 277.
Telephone, 277.
Thermometer, 164, 223.
Toad, 218.
Tomato, lesson plan on, 119.
Travel, means of, 276.
Trees, 205, 209, 212, 216, 220, 225;
  evergreens, 208, 215, 257;
  fruit, 251, 259;
  nut, 229, 234;
  shade, 239, 246;
  motivation of tree study, 88;
  materials for tree study, 89;
  collections for tree study, 89.
Trolley, 174.

Vegetables, 213;
  root, 229;
  salad, 248;
  vine crops, 250.
Ventilation, 161, 255, 265.
Vines, 104, 251, 263.
Violin, 181.

Water:
  hard and soft, 171;
  home supply, 184, 266.
Weather observations, 185.
Weather maps, 186.
Weather studies, 209, 216, 224.
Weeds, 135, 251, 275.
Window-boxes, 128.
Winter birds, lesson plan on, 65.
Wood, lesson plan on, 96.
Wren's house, lesson plan on, 65.

Yeast, 165.

RIVERSIDE TEXTBOOKS IN EDUCATION

RURAL LIFE AND EDUCATION.

By Ellwood P. Cubberley, Dean of the School of Education, Leland Stanford Junior University. $1.50 *net*. Postpaid.

THE HYGIENE OF THE SCHOOL CHILD.

By L. M. Terman, Professor of Education, Leland Stanford Junior University. $1.65 *net*. Postpaid.

EVOLUTION OF THE EDUCATIONAL IDEAL.

By Mabel I. Emerson, First Assistant in Charge of the George Bancroft School, Boston. $1.10 *net*. Postpaid.

HEALTH WORK IN THE SCHOOLS.

By E. B. Hoag, M.D., Medical Director, Long Beach City Schools, California, and L. M. Terman. $1.60 *net*. Postpaid.

DISCIPLINE AS A SCHOOL PROBLEM.

By A. C. Perry, Jr., District Superintendent of Schools, New York City. $1.40 *net*. Postpaid.

HOW TO TEACH THE FUNDAMENTAL SUBJECTS.

By C. N. Kendall, Commissioner of Education for New Jersey, and G. A. Mirick, formerly Deputy Commissioner of Education for New Jersey. $1.40 *net*. Postpaid.

TEACHING LITERATURE IN THE GRAMMAR GRADES AND HIGH SCHOOL.

By Emma M. Bolenius, formerly Instructor in English, Central Commercial and Manual Training High School, Newark, N. J. $1.40 *net*. Postpaid.

PUBLIC SCHOOL ADMINISTRATION.

By E. P. Cubberley. $1.75 *net*. Postpaid.

THE PSYCHOLOGY OF THE COMMON BRANCHES.

By F. N. Freeman, Assistant Professor of Educational Psychology, University of Chicago. $1.40 *net*. Postpaid.

THE MEASUREMENT OF INTELLIGENCE.

By L. M. Terman. $1.60 *net*. Postpaid.

Test Material for The Measurement of Intelligence. 50 cents *net*. Postpaid. Record Booklets (in packages of twenty-five). $2.00 *net*, a package. Postpaid.

EXPERIMENTAL EDUCATION.

By F. N. Freeman. $1.40 *net*. Postpaid.

AN INTRODUCTION TO EDUCATIONAL SOCIOLOGY.

By Walter R. Smith, Professor of Sociology and Economics, Kansas State Normal School, Emporia, Kansas. $1.75 *net*. Postpaid.

EDUCATIONAL TESTS AND MEASUREMENTS.

By W. S. Monroe, Professor of School Administration, and Director of the Bureau of Educational Measurements and Standards, Kansas State Normal School; J. C. DeVoss, Associate Professor of Psychology and Philosophy, Kansas State Normal School; and F. J. Kelly, Dean of the School of Education, University of Kansas. $1.50 *net*. Postpaid.

HOW CHILDREN LEARN.

By F. N. Freeman. $1.60 *net*. Postpaid.

STATISTICAL METHODS APPLIED TO EDUCATION.

By H. O. Rugg, Assistant Professor of Education, University of Chicago. $2.00 *net*. Postpaid.

TEACHING IN RURAL SCHOOLS.

By T. J. Woofter, Dean of the School of Education, University of Georgia. $1.40 *net*. Postpaid.

HEALTHFUL SCHOOLS: HOW TO BUILD, EQUIP, AND MAINTAIN THEM.

By May Ayres, Jesse F. Williams, M.D., Professor of Hygiene and Physical Education, University of Cincinnati, and Thomas D. Wood, A.M., M.D., Professor of Physical Education, Teachers College, Columbia University. $1.50 *net*. Postpaid.

AN INTRODUCTION TO CHILD PSYCHOLOGY.

By Charles W. Waddle, Ph.D., Supervisor of Practice Teaching, Los Angeles State Normal School. $1.50 *net*. Postpaid.

CLASSROOM ORGANIZATION AND CONTROL.

By J. B. Sears, Associate Professor of Education, Leland Stanford Junior University. (*In Press.*)

THE TEACHING OF SCIENCE IN THE ELEMENTARY SCHOOL.

By Gilbert H. Trafton, Instructor in Science, State Normal School, Mankato, Minnesota. $1.30 *net*. Postpaid.

Secondary Education Division

PRINCIPLES OF SECONDARY EDUCATION.

By Alexander Inglis, Assistant Professor of Education, Harvard University. $2.75.

PROBLEMS OF SECONDARY EDUCATION.

By David Snedden, Professor of Education, Teachers College, Columbia University. $1.50 *net*. Postpaid.

THE TEACHING OF ENGLISH IN THE SECONDARY SCHOOL.

By Charles Swain Thomas, Head of the English Department, Newton High School, Newton, Mass. $1.60 *net*. Postpaid.

HOUGHTON MIFFLIN COMPANY
BOSTON NEW YORK CHICAGO

1725b

1480

Q
181
.T8

1480

Q
181
.T8

Trafton, G. H.

Teaching of science in the elementary school.
'59'64'71 (18 issues)

DATE	ISSUED TO
NOV 29 19	J. Zuchow 292

KLINCK MEMORIAL LIBRARY
Concordia Teachers College
River Forest, Illinois
60305

DEMCO